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New species and new combinations in the genus *Swainsona* (Fabaceae) in New South Wales

Joy Thompson

Abstract

Thompson, Joy (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1990. New species and new combinations in the genus Swainsona *(Fabaceae) in New South Wales. Telopea 4(1): 1–5.* Three species *S. queenslandica, S. extrajacens* and *S. similis* are described and the species *S. bracteata, S. affinis* and *S. purpurea* raised from subspecific rank. The species *S. formosa* is transferred from the genus *Clianthus*. The affinity of each is discussed and brief notes on habitat and distribution given.

Swainsona Salisb. (1806)

1. S. bracteata (*Maiden & Betche*) *J. Thompson*, **comb. nov.**

BASIONYM: *S. greyana* var. *bracteata* Maiden & Betche (1903: 905).

HOLOTYPE: NEW SOUTH WALES: Central Western Slopes: between Gilgandra and Gummin, *W. Forsyth NSW 368*, 10.1901 (NSW).

SYNONYM: *S. greyana* subsp. *bracteata* (Maiden & Betche) A.T. Lee (1948: 158).

This species, formerly included in the related *S. greyana* Lindl., differs from that species in its calyx which, though often densely pubescent, lacks the dense, white woolly, tomentum of that species, and in its longer calyx-lobes and conspicuous bracts. It is found on lighter soils than those of the riverine habitat of *S. greyana*. It is widespread on the western slopes and plains of northern New South Wales and extends northward into Queensland.

2. S. queenslandica *J. Thompson*, **sp. nov.**

Herba fruticosa perennis usque ad c. 1 m alta. Foliola 19–25 plerumque peranguste ovata. Racemi usque ad 20 cm longi floribus c. 15 mm longis. Calyx lobis tubo brevioribus. Vexillum versus basim callis duobus magnis. Carina anguste obtusa. Stylus angustatus ad apicem. Fructus 25–40 mm longus c. 15 mm latus plerumque late ellipticus sutura non intrusa.

HOLOTYPE: NEW SOUTH WALES: North Western Slopes: 9 km W. of 'Gunyerwarildi' on Crooble road, *K.L. Wilson 2481*, 28.11.1982 (NSW). ISOTYPES: BRI, K, MO, L, RSA.

A soft-wooded perennial shrub to a metre or more in height. *Stems* usually 3–5 mm or even more in diameter, glabrous or with sparse, fine, irregularly spreading basifixed hairs, mostly 0.5 mm or less in length. *Leaflets* 19–25, usually very narrowly ovate, glabrous or almost so, the apex rounded to emarginate, often with a small point. *Stipules* to c. 3 mm long, deltoid to long-deltoid, acuminate, joined to form an abaxial ridge, glabrous. *Racemes* mostly 15–20 cm or more in length, often with c. 20 flowers of various colours (white, pink, or purplish pink to orange-red or dark red), mostly c. 15 mm long and on minutely puberulous pedicels, the peduncle glabrous or, more usually, with fine crisped hairs and without a pulvinus. *Calyx* with the tube 2–3 mm long and the lobes deltoid, obtuse to very shortly acuminate, and much shorter than the tube. *Standard* c. 15 mm long and as wide or wider. *Wings* often 10–15 mm long, mostly

oblong or with the apex broader, and usually shortly obtuse. *Keel* 10–15 mm long and 4–5 mm deep, the apex rather narrowly obtuse and obscurely lipped. *Ovary* 4–8 mm long, glabrous, with some hairs near the base or densely partly or wholly pubescent. *Style* slender beyond the base, thin-textured, tapering to a straight, slender tip, without a tuft of hairs. *Fruit* 25–40 mm long and c. 15 mm wide, usually broadly elliptic, much inflated, the suture not intruded, the funicular tissue evident but very short, the apex almost rounded behind a short beak, the base with a stipe 5–10 mm long.

This species has been included in the related *S. galegifolia* (Andr.) R. Br. by most authors. It can be distinguished from *S. galegifolia* by its wing petals, which are approximately equal to, rather than shorter than, the keel, and by its pubescence; and from *S. bracteata* by its long wing petals and its small bracts. It is common on heavy soils on the north-western slopes of New South Wales and in the Darling Downs district of Queensland, and it extends northward to c. 20°S latitude.

The species is named for the fact that it is the most common member of the *S. galegifolia-greyana* group of species in Queensland. Many Queensland references to *S. galegifolia* (a species of restricted distribution in Queensland) are based on this taxon.

3. S. affinis *(A.T. Lee) J. Thompson*, **comb. nov.**

BASIONYM: *S. microphylla* subsp. *affinis* A.T. Lee (1948: 256).

HOLOTYPE: NEW SOUTH WALES: North Western Slopes: Dunlop Station, west side of Darling R., *Etheridge 10*, 7.1903 (NSW).

SYNONYM: *S. microphylla* subsp. *glabrescens* A.T. Lee (1948: 255), quoad holotypum (most cited specimens being *S. microphylla* A. Gray). HOLOTYPE: WESTERN AUSTRALIA: near Barrow Range, Camp 33, Elder Exploring Expedition, *Helms NSW 717*, 17.8.1891. ISOTYPE: AD (pro parte, the sheet at AD cited by Lee including material of *S. microphylla*).

S. microphylla subsp. *pallescens* A.T. Lee (1948: 255). HOLOTYPE: QUEENSLAND: Herberts Creek, *Bowman* (MEL). ISOTYPE: NSW 732.

This species differs from the related *S. microphylla* sens. str. in having a slender, variously extended, anvil-shaped style-tip, rather than a truncate tip (see Lee, op. cit.: 258, figs 52a and 52b), and in having fewer leaflets. It is widespread, often in red loamy soil and associated with *Callitris* and mulga. It is found in all States except Victoria and Tasmania.

4. S. similis *J. Thompson*, **sp. nov.**

Herba erecta sed adscendens perennis usque ad c. 25 cm alta. Foliola 5–15 plerumque elliptica. Racemi usque ad c. 25 cm longi floribus 6–7 mm longis. Calyx lobis tubo aequalibus sed longioribus. Vexillum versus basim cum vel sine lineis crassis vel area crassa. Carina acuta. Stylus vix angustatus ad apicem oblique truncatum. Fructus 6–15 mm longus 5–8 mm latus ovoideus fere orbicularis sutura intrusa.

HOLOTYPE: NEW SOUTH WALES: North Western Plains: 4 miles (6 km) SW of Brewarrina on Tarcoon road, *J. Thompson NSW 87222*, 5.9.1968 (NSW).

SYNONYM: *S. parviflora* var. *vestita* C.T. White & Francis (1926: 156). HOLOTYPE: QUEENSLAND: Adavale, *W. MacGillivray 991*, 28.8.1923 (BRI). ISOTYPE: NSW 221. This specimen is somewhat atypical.

An erect or ascending perennial to c. 25 cm in height. Stems 0.5–1.5 mm in diameter, with sparse appressed basifixed or subbasifixed hairs less than 0.5 mm long. *Leaflets* 5–15, in general elliptic, often narrowly so, broader and more obtuse near the base of

the plant, 5–8 (–>20) mm long, the appressed pubescence usually sparse and confined to the lower surface, the apex obtuse or acute, rarely retuse, with a short point. *Stipules* 1–6 mm long, deltoid to very long-narrow-deltoid, often failing to form an abaxial ridge but with the petiole tending to form a joint, with sparse hairs on both surfaces. *Racemes* 10 to almost 25 cm long, with 5–15 purple flowers 6–7 mm long on pubescent pedicels, the peduncle with scattered minute appressed or divergent antrorse hairs, often dark, and often dense on the upper part, and usually with a distinct dark and pubescent pulvinus. *Calyx* with the tube c. 2 mm long and the lobes acuminate-deltoid, variably attenuate and usually almost equal to, or occasionally shorter than the tube. *Standard* 7–11 mm long and as wide or a little less in width, with or without slender ridges or an amorphous thickening near the base. *Wings* 5.5–9 mm long, broadly obovate, the apex much expanded and very shortly obtuse. *Keel* 5.5–7 mm long and 2.5 mm deep, the apex acute with a narrow beak-like tip. *Ovary* 2–2.5 mm long, with minute hairs over most of the surface but sometimes absent from the lower (non-sutural) side. *Style* broad at the base, somewhat stiffened above and scarcely or not tapered behind an obliquely truncate tip with a minute tuft of hairs behind it. *Fruit* 6–15 mm long and 5–8 mm wide, shortly ovoid or oblong-elliptic, to almost round, inflated but dorsiventrally compressed, the suture intruded, the funicular tissue short or minimal, the apex broadly and obliquely rounded below a short beak, the base with a minute stipe.

This species has affinities with *S. recta* A.T. Lee but differs in lacking an abaxial stipular ridge, having calyx-lobes as long as or longer than the tube and having a pulvinus at the base of its peduncle. It differs from *S. parviflora* Benth. in habit, being erect or ascending rather than prostrate. The species is found on red soil in grassland or open woodland on the western plains of New South Wales and in inland parts of southern Queensland.

It is named for its similarity to these related species.

5. S. extrajacens *J. Thompson*, **sp. nov.**

Herba erecta probabiliter annua usque ad c. 30 cm alta. Foliola 9–21, ovata vel ovato-elliptica. Racemi usque ad c. 15 cm longi floribus 6–8 mm longis. Calyx lobis tubo brevioribus. Vexillum versus basim area crassa bilobata. Carina apice anguste acuta et elevata. Stylus lato basi parvus angustatus apice lato. Fructum maturum non vidi.

HOLOTYPE: NEW SOUTH WALES: North Far Western Plains: 'Narriearra', *L. Richley SCS 1482*, 4.7.1974 (NSW).

An erect, apparently annual plant from 10 to c. 30 cm tall. *Stems* mostly 2–4 mm in diameter, with rather sparse, fine, mostly spreading, often irregularly crisped, basifixed hairs c. 0.75 mm long. *Leaflets* 9–21 (fewer on younger plants), ovate to ovate-elliptic, mostly 10–15 mm long (often wider at the base of the plant), with a loose pubescence often restricted to the margins on the upper surface, the apex retuse to emarginate, often recurved with a short point. *Stipules* c. 5 mm long, mostly narrowly lanceolate above a broad base, not joined in an abaxial ridge, the pubescence on both sides but mostly near the margins. *Racemes* 5- c. 15 cm long, with 5–10 purple flowers 6–8 mm long, on densely pubescent pedicels, the peduncle with a sparse spreading pubescence often more antrorse and dense in the upper part, and without a pulvinus. *Calyx* with the tube c. 2 mm long and the lobes deltoid-acuminate and shorter than the tube. *Standard* 8–9 mm long and a little wider, with a 2-lobed prominent thickening near the base. *Wings* 7–8 mm long, obovate, with the apex very shortly obtuse. *Keel* 6–8 mm long and c. 2.5 mm deep, the apex narrowly acute and upcurved so that the narrow beak-like tip is well behind the end. *Ovary* c. 3 mm long, glabrous or with a few long hairs near the base. *Style* tapering slightly and evenly from a rather broad base that

extends above the ovary-tip, not much thickened, the stigmatic end rather broad and sometimes bent to one side, with a forwardly directed tuft or line of minute hairs just behind it. *Fruit* not seen mature.

This eremaean species of obscure affinity was referred to as *Swainsona* sp. A. in Jacobs & Pickard (1981). It is found with annual saltbushes in the north-western corner of New South Wales and the adjacent part of eastern South Australia.

It is named for its location remote from populated areas.

6. S. purpurea *(A.T. Lee) J. Thompson,* **comb. nov.**

BASIONYM: *S. stipularis* var. *purpurea* A.T. Lee (1948: 213).

HOLOTYPE: SOUTH AUSTRALIA: Camp 41, between the Warburton River and Lake Eyre, near Poonarunna homestead (ruins), *Simpson Desert Expedition,* 28.7.1935 (AD).

SYNONYM: *S. stipularis* var *longialata* A.T. Lee (1948: 213). HOLOTYPE: NEW SOUTH WALES: North Far Western Plains: Bulloo Overflow, *N.C.W. Beadle NSW 613,* 12.8.1941 (NSW).

This species differs from *S. stipularis* F. Muell. especially in its narrow and entire stipules, its slender and tapering style and its purple (as opposed to usually orange) flowers. Usually associated with margins of salt and/or gypsum lakes, it is a variable species extending from far western New South Wales and the south-western corner of Queensland to Western Australia.

7. S. formosa *(G. Don) J. Thompson,* **comb. nov.**

BASIONYM: *Donia formosa* G. Don (1832: 468).

HOLOTYPE: WESTERN AUSTRALIA: North-west coast of New Holland at the Curlew River, *King* (BM, n.v.).

SYNONYM: *Clianthus formosus* (G. Don) Ford & Vickery (1950: 302). For further synonymy see Ford and Vickery, op. cit.: 303.

This species, widespread from inland areas of western New South Wales to the coast of Western Australia, has little affinity with *Swainsona* species of eastern Australia but is related to several in Western Australia. It is closely related to *S. beasleyana* F. Muell. from which it differs in its larger usually red (not purple) flowers, acute keel and longer fruit. Its former inclusion in the New Zealand genus *Clianthus* Soland. ex Lindl. was based on a superficial floral resemblance rather than close affinity. This taxon differs from the single species of *Clianthus* in its restricted inflorescence, its well-developed calyx-lobes, its narrow, long, cylindrical and bilocular pods, its pubescence of fine spreading hairs, its large, broad, pubescent, toothed stipules and its prostrate habit.

References

Don, G. (1832) *A General History of the Dichlamydeous Plants* 2 (J.G. & F. Rivington et al.: London)

Ford, N.C., & Vickery, J.W. (1950) The correct name of Sturt's Desert Pea, *Clianthus formosus* (G. Don) comb. nov. *Contr. New South Wales Natl. Herbarium* 1(5): 302–303.

Jacobs, S.W.L., & Pickard, J. (1981) *Plants of New South Wales* (Government Printer: Sydney)

Lee, A.T. (1948) The Genus *Swainsona. Contr. New South Wales Natl. Herbarium* 1(4): 131–271.

Maiden, J.H., & Betche, E. (1903) Notes from the Botanic Gardens, Sydney, No. 9. *Proc. Linn. Soc. New South Wales* 28: 904–923.
Salisbury, R.A. (1806) *The Paradisus Londinensis* (William Hooker: London)
White, C.T. & Francis, W.D. (1926) Contributions to the Queensland Flora, No. 3. *Proc. Roy. Soc. Queensland* 37: 152–167.

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Notes on *Stipa* (Poaceae) in Australia and Easter Island

J. Everett and S.W.L. Jacobs

Abstract

Everett, J. and Jacobs, S.W.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1990. Notes on Stipa *(Poaceae) in Australia and Easter Island. Telopea 4(1): 7–11.* The applications of the names of three South American species are reviewed and it is concluded that *S. caudata* is the correct name for one of the species introduced into Australia, but that *S. brachychaeta* is also established in this country. *S. horridula* Pilger (1922), described from Easter Island, is lectotypified and reduced to a synonym of *S. scabra* Lindley subsp. *scabra*. Possible means of introduction of *S. scabra* to Easter Island and its apparent population fluctuations there are discussed.

Introduction

In the treatment of the Australian species of *Stipa* (Vickery, Jacobs & Everett 1986) there were some intractable problems that, at the time, we were not in a position to solve. We are now able to provide more information on, and a suggested treatment for, one problem and the solution to another.

(i) S. caudata, S. brachychaeta and S. bertrandii

We included the following note under *S. caudata* Trin. (Vickery et al. 1986: 39):

'*S. caudata* has been known in Australia as *S. brachychaeta* Godron, Mem. Sect. Sci. Acad. Sci. Montpellier 1: 450 (1853). (The latter name appears on some of our determinavit labels.) These two South American species are difficult to distinguish. They are generally said to be distinguished by:

(i) *S. caudata* having hairs on the margins and midrib of the lemma, and a broader caryopsis with an eccentric stylar appendage;

(ii) *S. brachychaeta* having hairs all over the lemma surface, and a narrower caryopsis with a centric stylar appendage.

The type of *S. brachychaeta* (*Godron*, (NCY!)) has lemmas showing both character states on the one inflorescence. In Australian specimens, the only caryopses we have found are immature and in a glasshouse-grown specimen (*Morris*, 19.1.1981 (HO)); and these match the description of *S. caudata*. We have as yet been unable to find caryopses of either *S. brachychaeta* or *S. caudata* for comparison. We are using the earlier name *S. caudata* although we are not yet convinced the situation is fully understood.'

Caro and Sanchez (1971) revised the complex of three species containing *S. caudata*, *S. brachychaeta*, and *S. bertrandii* Philippi. Collections in many major herbaria confuse the three. We borrowed as many specimens as possible of the three species from South American herbaria, especially those specimens that had been seen by either Caro or Sanchez. From the revision and the specimens it was clear that the three species were closely related but distinct. It was also clear that mature caryopses were the most reliable way of distinguishing *S. brachychaeta* from *S. caudata* and *S. bertrandii*. With more recent Australian collections we now have some with mature caryopses. It is also

now apparent that at least two species of the complex are present in Australia. Mature seeds are not common and it appears that, in Australia, reproduction and dispersal is at least partly dependent on the cleistogenes produced in the basal leaf sheaths.

Three Australian specimens, two from Merriwa (N.S.W., CWS) and one from Quirindi (N.S.W., NWS), match *S. brachychaeta*.

The commoner of the two taxa in Australia is either *S. caudata* or *S. bertrandii*. Caro and Sanchez (1971) distinguished these two species by:

(i) the lemmas of *S. caudata* being hairy on the midnerve and margins and glabrous between the midnerve and *the first lateral nerve*, and having leaves 1–3 mm wide and,

(ii) the lemmas of *S. bertrandii* being hairy on the midnerve and margins and glabrous between the midnerve and *the (two) lateral nerves*, and having leaves 3–7 mm wide.

The distinctions as given are precise but, judging from the determinavits of Caro and Sanchez, the situation is rather more complex. We can see no justification for dividing this Australian material into two taxa; equally we can see no reason to change the name of that taxon so are maintaining the name *S. caudata* for the bulk of our Australian material.

Both *S. caudata* and *S. brachychaeta* will key to 'Group B' in Vickery et al. (1986) and can be distinguished by the following key:

1 Caryopsis obovoid, the style base central; lemma surface more or less hairy all over though often with a bare area between the midnerve and first lateral nerve, especially towards the apex. **S. brachychaeta**

1* Caryopsis broadly obovoid or almost gibbous, the style base eccentric; lemma surface hairy along the midrib and between the outermost lateral nerves on the margin, the area between the midnerve and the first lateral nerve more or less glabrous. **S. caudata**

S. brachychaeta was not included in Vickery et al. (1986) so a description is given here.

***S. brachychaeta** *Godron* (1853: 450); Rosengurtt, de Maffei & de Artucio (1970: 73); Caro & Sanchez (1971: 638).

TYPIFICATION: Caro and Sanchez (1971) cite a specimen held at MPU and labelled in Delile's handwriting as the type. There is a specimen with the rest of Godron's herbarium held at NCY(!) labelled in Godron's handwriting. Unfortunately, the date on this latter specimen could be interpreted as being later than 1853. This is clearly a case requiring lectotypification but it is preferable for someone more familiar with all the species of the group to select a lectotype.

Caespitose perennial to c. 1 metre high with a basal tuft to three quarters the height, without rhizomes. *Culms* erect, terete, not compressible, smooth to slightly ribbed; nodes 2–5, ± exserted, glabrous, not or only slightly swollen. *Leaf* sheaths becoming loose with age, glabrous; basal sheaths 3–6 mm wide, slightly ribbed, margins glabrous; upper sheaths 2–3.5 mm wide, strongly ribbed, margins glabrous except for a few hairs 0.4–1.5 mm long near the ligule. *Ligule* truncate, membranous, 0.1–0.5 mm long, ciliate with hairs 0.5–1.5 mm long, also with a tuft of hairs at the sides; auricles absent. *Leaf blade* expanded to tightly rolled, 1–2.5 mm wide, to 50 cm long; abaxial surface strongly ribbed, glabrous; adaxial surface strongly ribbed, minutely scabrous; margin minutely scabrous. *Panicle* 15–25 cm long, exserted, with distant fascicles of unequal, few-flowered, compound branches, contracted, c. 2.5 cm wide (excluding awns); axis terete to slightly flattened, moderately ribbed, scaberulous on the margins;

branches to 8 cm long, angled, scaberulous along the angles with hairs c. 0.1 mm long; pedicels to c. 8 mm long, slightly angled, scaberulous along the angles with hairs c. 0.1 mm long. *Spikelets* 6–7 mm long (excluding awn), gaping. *Glumes* subequal, hyaline with chlorenchyma bands associated with the nerves, acuminate; lower glume 6–7 mm long, glabrous or scaberulous along the midrib with hairs minute-0.2 mm long, lower 40–50% 3-nerved, the remainder 1-nerved; upper glume 5.5–7 mm long, glabrous or scaberulous along the midrib with hairs minute-0.2 mm long, lower 40–50% 3-nerved, the remainder 1-nerved. *Floret* cylindrical, 4.5–6 mm long (including callus), with a weakly developed neck. *Lemma* surface scaberulous with minute tubercles, with hairs 0.2–1 mm long mainly on the midrib and margins but also scattered variously or more or less glabrous (especially in the upper half) in the region between the midrib and lateral nerves; lobes 0.1–0.2 mm long; coma of hairs 0.2–0.7 mm long. *Callus* c. 0.5 mm long, straight, blunt, densely sericeous with white hairs to 0.3 mm long. *Awn* 1–1.5 cm long, once or twice bent, c. 0.2 mm wide near the base; column 4–6 mm long, 2–3 mm to the first bend, straw-coloured, scaberulous with minute hairs; bristle straw-coloured, scaberulous with minute hairs. *Palea* ± equal to the lemma, ± smooth, with a row of hairs 0.2–0.6 mm long down the centre back. *Lodicules* 3; 2 abaxial, membranous, ± oblong, 0.6 mm long; paleal membranous, acute, c. 0.3 mm long. *Anthers* 2.5 mm long, penicillate. Only immature caryopsis seen, obovoid, c. 2 mm long [2–3 mm long in non-Australian specimens], embryo 30% the length, hilum c. 75% the length, the stylar appendage ± centric. Cleistogenes present in the lower leaf sheaths.

DISTRIBUTION: An introduction from South America, recorded from near Merriwa (CWS) and Quirindi (NWS), New South Wales.

SPECIMENS SEEN: NEW SOUTH WALES: North Western Slopes: Quirindi, *Cherry s.n.*, 23.5.1989 (NSW). Central Western Slopes: Merriwa district, *Henderson NSW 117377*, 15.11.1955 (NSW), *Merriwa Shire Council NSW 117378*, 1.1956 (NSW).

A specimen of *S. caudata* (*W.E. Mulham 1604*) with mature seed, allows us to provide the following additional information on the caryopsis of that species:

Caryopsis broadly obovoid, 2–3 mm long, embryo 25–30% the length (but not easily visible), hilum c. 90% the length, the stylar appendage eccentric.

S. caudata also usually produces cleistogenes in the lower leaf sheaths.

SELECTED SPECIMENS: NEW SOUTH WALES: South Western Slopes: Cootamundra district, *Christenson NSW 117379*, 5.11.1959 (NSW). South Western Plains: 20 km NE of Deniliquin, *W.E. Mulham 1604*, 11.1986 (NSW). VICTORIA: Parish of Dunolly, *M.J. Lindsay*, 30.11.1984 (MEL 671120). TASMANIA: Flinders Island: Emita, *Warren NSW 117376* 4.12.1979 (NSW).

(ii) **S. horridula** *Pilger*

This species was described in 1922 (Skottsberg 1922) from Easter Island and was considered endemic there. Only one specimen was collected, with several duplicates. Unfortunately, all of the duplicates were immature. It was obvious to us, however, that the specimen belonged to the Falcateae, thought to be a group endemic to Australia. The species then was either of interest biogeographically, or was important nomenclaturally as its epithet predated many of the names used for the Falcateae in Australia. After examining some of the duplicates (K, S, GB) it was not possible to decide to which species Skottsberg's collection belonged. No other collections of the taxon could be found. Eventually one of us (JE) was able to collect good specimens on Easter Island in 1987 and to ascertain that the taxon was *S. scabra* Lindley subsp. *scabra*.

Stipa scabra *Lindley* in Mitchell (1848:31) subsp. **scabra**

SYNONYM: *Stipa horridula* Pilger in Skottsberg (1922: 64, pl. 6) *syn. nov.*

LECTOTYPE, here designated: EASTER ISLAND: Isla de Pascua slope of [Mt] Katiki, *Skottsberg 660*, 16.6.1917 (GB; dupls S, K). There is no specimen extant at B where Pilger's types would be expected. The duplicate at GB is with many of Skottsberg's other specimens; it is the best developed and most mature of the duplicates, and has been seen and annotated by Pilger.

Stipa does not appear in a list of species of Easter Island prepared in 1911 (Knoche 1925). It was collected in 1917 ('Mt Katiki, stray patches on the western slope') by Skottsberg (1922) and described as being '... observed in this association [grassy slopes of Maunga Katiki] forming a couple of small societies on the seaward slope' (Skottsberg 1927). In 1981 it was mapped as one of the dominant species in ten areas accounting for c. 4–5% of the area of the island (Etienne et al. 1982) but by 1983 was described as being restricted to the western slope of Mt Katiki (Etienne & Faundez 1983). By 1987 it was only present in one of the eight areas visited (by JE) of the ten described by Etienne et al. (1982) and also on the western slope of Mount Katiki, but restricted to a few plants in both localities.

The introduction, spread and decline of the species on the island seems to be directly related to agricultural practices. Missionaries brought livestock to the island, supposedly from Australia, in 1860. Further imports occurred; for example, the 'Sydney Morning Herald' recorded a shipment of 400 merinos in December 1871. As well as the livestock imports providing a possible origin for the diaspores, a manager of the Williamson Balfour Pastoral Company, the company managing the island, introduced seeds of many Australian species, including 29 spp. of *Eucalyptus* during 1902–1929 (S. Rapu pers. comm.). The timing of the collections and spread of *Stipa* would probably indicate an introduction during the earlier period but either option is possible.

The sudden decline of the *Stipa* seems to be related to the rapid spread of the less palatable *Sporobolus africanus* [*S. indicus*] and the preferential grazing of *Stipa* by cattle. *Stipa* is now almost restricted to areas not readily accessible to cattle.

References

Caro, J.A. , & Sanchez, E. (1971). La identidad de *Stipa brachychaeta* Godron, *S. caudata* Trinius y *S. bertrandii* Philippi. *Darwiniana* 16: 637–653.

Etienne, M.G. & Faundez, L.Y. (1983). *Gramíneas de isla de Pascua* (Universidad de Chile) 57 pp.

Etienne, M., Michea, G. & Diaz, E. (1982). *Flora, vegetacion y potencial pastoral de isla Pascua.* Universidad de Chile, Facultad de Ciencias Agrarias, Veterinarias y Forestales, Boletin Tecnico 47.

Godron, D.R. (1853). Flora Juvenalis. *Mémoires de l'Academie des Sciences et Lettres de Montpellier, sect. Medicine* 1: 409–456.

Knoche, W. (1925). *Die Osterinsel* (Verlag des Wiss. Archivs von Chile: Concepcion)

Mitchell, T.L. (1848). *Journal of an expedition into the interior of tropical Australia in search of a route from Sydney to the Gulf of Carpentaria* (Longman, Brown, Green & Longmans: London) 437pp.

Rosengurtt, B., de Maffei, B.R.A. & de Artucio, P.I. (1970). *Gramíneas Uruguayas* (Universidad de la República: Montevideo) 491 pp.

Skottsberg, C. (1922). The phanerogams of Easter Island. In C. Skottsberg (ed.), *Natural history of the Juan-Fernandez and Easter Islands*, vol. 2 botany: 61–84.

Skottsberg, C. (1927). The vegetation of Easter Island. In C. Skottsberg (ed.) *Natural history of the Juan-Fernandez and Easter Islands*, vol. 2 botany: 487–503.

Vickery, J.W., Jacobs, S.W.L. & Everett, J. (1986). Taxonomic studies in *Stipa* (Poaceae) in Australia. *Telopea* 3: 1–132.

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Four new species of *Zygophyllum* (Zygophyllaceae) and one lectotypification

Hansjoerg Eichler

Abstract

Eichler, Hansjoerg (Australian National Herbarium, CSIRO, G.P.O. Box 1600, Canberra, A.C.T. 2601) 1990. Four new species of Zygophyllum *(Zygophyllaceae) and one lectotypification. Telopea 4(1): 13–17.* The new species *Zygophyllum angustifolium, Z. confluens, Z. emarginatum* and *Z. simile* are described and their general distribution outlined. Representative specimens from New South Wales localities are listed. A lectotype of *Z. ammophilum* F.Muell. is designated.

The names of four new species of *Zygophyllum* need validation in order to be used in the forthcoming 'Flora of New South Wales'. The brief Latin descriptions of the salient features and the designation of the holotypes required by the International Code of Botanical Nomenclature, slightly more elaborate English descriptions, an indication of the distribution, and notes on distinctive characters of the species with which the new species had hitherto been confused, are provided below. As this paper is a precursor to the 'Flora of New South Wales', only specimens examined from localities in New South Wales are listed.

1. Zygophyllum angustifolium *H. Eichler*, **sp. nov.**

Fruticulus tenuis, plerumque 30–60 cm altus, glaber. Folia petiolata, unijugata; foliola linearia vel peranguste oblongi-elliptica, 10–30 mm longa, 2–4 mm lata, ad basim constricta, articulata, ad apicem acuta. Petala 4, flava, anguste obovata vel elliptica, 4–8 mm longa, sepalis 1/4–1/3 plo longiora. Stamina 8; filamenta subulata, exalata, haud appendiculata. Discus 4-partitus; lobi disci discreti, carnosi, semiorbiculares, margine papilloso. Capsula obconica, 6–9 mm longa, tetragona, 4-cellularis, apice truncata; cellula 1- vel 2-seminalis.

HOLOTYPUS: *Hj. Eichler 20655*: South Australia. Gawler Ranges. Yandinga Gorge: in valley near waterfall c. 35 km north-north-east of Minnipa. 32° 33'S, 135° 20'E. 14 Oct 1969 (CANB 385209). ISOTYPI: AD, B, CANB, G, K, L, MEL, NSW, PERTH, US.

Slender, glabrous shrublet, usually 30–60 cm high, sometimes scrambling over taller plants and then reaching 150 cm or more. *Leaves* petiolate, with one pair of leaflets; leaflets succulent, linear to narrowly oblong-elliptic, 10–30 mm long, 2–4 mm wide, narrowed and articulate at base, acute at apex. *Petals* 4, pale yellow, narrowly obovate to elliptic, 4–8 mm long, about 1/4–1/3 times longer than sepals. *Stamens* 8; filaments subulate, c. 3 mm long, without wings or appendage; anthers oblong, c. 3/4 mm long. *Disc* 4-lobed; lobes free, succulent, semicircular, with papillose margin. *Ovary* broad-oblong, c. 2 mm long, truncate at apex, glabrous; style subulate, c. 1.5–2 mm long; stigma minutely 4-lobed. *Fruiting pedicels* 8–25 mm long. *Capsule* obconical, 6–9 mm long, 4-angled, 4-celled, truncate at apex, with 1 or usually 2 seeds per cell; style persistent, 1.5–3 (rarely 4) mm long.

Southern mainland Australia: Western Australia (Eucla), South Australia (Nullarbor, Gairdner-Torrens Basin, Flinders Range, Eastern Region, Eyre Peninsula, Northern Lofty, Murray, northern Yorke Peninsula), New South Wales (South Far Western Plains), and far north-western Victoria.

SELECTED SPECIMENS: NEW SOUTH WALES: South Far Western Plains: 'Prungle', Balranald, *G.M. Cunningham & P.L. Milthorpe 2445*, 23 Jul 1974 (NSW); near 'Bidura', north-west of Balranald, *J.H. Leigh & W.E. Mulham W269*, 12 Aug 1968 (NSW); Mallee Cliffs National Park, c. 60 km east of Mildura, *M. Fox 8310481 & H. Fallding*, 22 Oct 1983 (NSW); 25 km north-west of Balranald, red clay loam, *M. Fox 8402167a & 8402174*, 19 Feb 1984 (NSW); Balranald, *T. Lucas* 22, 1878 (MEL 94817); Murray River (locality not defined), *F. Mueller NSW 14437*, without date (NSW).

Z. angustifolium is well illustrated in G.M. Cunningham, W.E. Mulham, P.L. Milthorpe and J.H. Leigh, Plants of western New South Wales (1981), on p. 439 (colour photograph), wrongly under the name *Z. billardierei* var. *bilobum*, which is a synonym of *Z. confluens* and differs from *Z. angustifolium* by its leaflets being continuous with the petiole, larger petals and more robust habit. *Z. billardierei* DC., which is confined to coastal areas, is distinguished mainly by its more robust habit, longer and broader petals, and broader leaflets. *Z. ammophilum* F. Muell., with which *Z. angustifolium* has also been confused, is a small annual with much smaller, inconspicuous flowers, white petals, 4 stamens, and smaller capsules with 3 or 4 seeds per cell.

2. Zygophyllum confluens *H. Eichler*, **sp. nov.**

Suffrutex erectus, usque ad 70 cm altus, glaber. Folia petiolata, unijugata; foliola carnosa, linearia, 10–20 mm longa, in petiolum confluentia (i.e., ad basim non articulata), ad apicem acuta. Petala 4, aurea, obovata, 9–12 mm longa, sepalis conspicue longiora. Stamina 8; filamenta subulata, ad basim dilatata, haud appendiculata. Discus 4-partitus; lobi disci discreti, carnosi, semiorbiculares, margine papilloso. Capsula late obovata vel turbinata ad campaniformis, 8–11 mm longa, tetragona, 4-cellularis, apice truncata; cellula 1- vel 2-seminalis.

HOLOTYPUS: *Hj. Eichler 17211*: South Australia. Murray River District. C. 18 km west-south-west of Purnong, at turnoff to Walker Flat on road to Mannum; on roadside. 34° 51'S, 139° 29'E. 11 Aug 1963 (CANB 390427). ISOTYPI: AD, B, CANB, K, MEL, NSW.

Erect, glabrous subshrub, to 70 cm high. *Leaves* petiolate, with one pair of leaflets; leaflets succulent, linear, usually 10–20 mm long, continuous with the petiole (i.e. not articulate at base), acute or mucronulate at apex. *Petals* 4, golden yellow, obovate, 9–12 mm long, distinctly longer than sepals. *Stamens* 8; filaments subulate, c. 5.5 mm long, gradually broadened towards the base, without appendage; anthers oblong, c. 1.5 mm long. *Disc* 4-lobed; lobes free, semicircular to broader than long, densely papillose at the margin. *Ovary* 4-angled, 4-celled, oblong, c. 2.5 mm long, glabrous, ± abruptly narrowed into the style; style subulate, 2–4 mm long; stigma minute, not lobed. *Fruiting pedicels* 9–25 mm long. *Capsule* broadly obovate or turbinate to bell-shaped, 8–11 mm long, 4-angled, 4-celled, ± truncate at apex, with 1 or less frequently 2 seeds per cell; fruiting style 4–5 mm long.

South Australia (Lake Eyre Basin, Gairdner-Torrens Basin, Flinders Range, Eastern Region, Eyre Peninsula, Northern and Southern Lofty, Murray), and New South Wales (North Far Western Plains).

SELECTED SPECIMENS: NEW SOUTH WALES: North Far Western Plains: Barrier Ranges, *Mrs. Irvine s.n.*, Jun 1889 (MEL 95424); Umberumberka, Broken Hill, *A. Morris 310*, 4 Aug 1920 (NSW); Barrier Range, Umberumberka, *L.A.S. Johnson NSW 144844*, 29 Aug 1946 (NSW); near Silverton, *E.N. Charsley s.n.*, 1886 (MEL 94955); Broken Hill, *E.C. Andrews NSW 144842*, Sep 1918 & Dec 1919 (NSW); Broken Hill, *A. Morris 2067*, 1 Jul 1928 (BRI 068187); Broken Hill, *V. Benešova s.n.*, Aug 1950 (P).

Z. confluens has usually been confused with the coastal *Z. billardierei* DC., which is easily distinguished by its articulate, usually much broader leaflets. The two species rarely occur together.

3. Zygophyllum emarginatum *H. Eichler*, **sp. nov.**

Herba annua, usque ad 30 cm alta, glabra, plerumque basiramifera, effusa. Folia petiolata, unijugata; foliola carnosa, anguste obtriangularia, 4–8 mm longa, 3–5 mm lata, ad basim subarticulata, ad apicem plerumque emarginata. Petala 4, lutea, obovata vel elliptica, 2–3 mm longa, sepala aequantes vel paulo longiora. Stamina 8, c. 2 mm longa; filamenta in dimidio inferiore abrupte alata. Discus 4-partitus; lobi disci discreti, carnosi, oblongi, apice dense papilloso. Capsula late turbinata, 5–7 mm longa, tetragona, 4-cellularis, apice late tholiformi vel applanato; cellula 1- vel 2-seminalis.

HOLOTYPUS: *J.Z. Weber 2954*: South Australia. North West Plains. Sloanes Bore Outstation, which is on Millers Creek Station and c. 40 km north of Mount Eba on Stuart Highway. 30° 00'S, 135° 41'E. 9 Oct 1971. (CANB 326258). ISOTYPI: AD, CANB, COLO, HO.

Glabrous annual, to 30 cm high, usually spreading and branched from the base. *Leaves* petiolate, with one pair of leaflets; leaflets succulent, narrow-obtriangular, 4–8 mm long, 3–5 mm wide, at the base ± articulate, at the apex usually emarginate. *Sepals* 4, 2–3 mm long. *Petals* 4, yellow (when fresh), narrow-obovate to elliptic, as long as, or slightly longer than, sepals. *Stamens* 8, c. 2 mm long; filaments abruptly winged in the lower half (wing at top truncate or often with one tooth at each side of the filament). *Disc* 4-lobed; lobes free, succulent, oblong, densely papillose at apex. *Ovary* 4-celled, 4-angled, papillose along the angles, glabrous at truncate apex; style c. 0.5 mm long; stigma almost capitate. *Capsule* broadly turbinate, 5–7 mm long, 4 angled, 4-celled, at apex widely dome-shaped, with 1 or 2 seeds per cell.

Z. emarginatum is known to occur in dry inland Australia in the following regions: Northern Territory (Central North, Central South), Queensland (Gregory North, Gregory South), South Australia (eastern part of Northwestern Region, Lake Eyre Basin, Gairdner-Torrens Basin, northern Flinders Range), and New South Wales (North Western Plains, North Far Western Plains). In contrast to *Z. simile* and *Z. ammophilum*, which occur on sandy soils, *Z. emarginatum* prefers stony and rocky ground.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Western Plains: Bourke, *L. Henry NSW 145379*, 1884 (NSW). North Far Western Plains: 1 mile south of Mt Poole Homestead, on stony plain, brown gibber with gilgai, *G.M. Cunningham & P.L. Milthorpe 1088*, 16 Sep 1973 (NSW); 5 km west of Milparinka on road to Hawker Gate, *B.G. Briggs 5406*, 26 Sep 1974 (AD, NSW, CANB); Fowlers Gap, *B. Rice 2732*, 2 Aug 1978 (CANB).

Z. ammophilum and *Z. simile* resemble *Z. emarginatum* in habit, but are both easily distinguished from it by their white petals, linear-oblong shape of leaflets and 4-lobed stigma. The yellow petals of *Z. emarginatum* fade to white when dried; therefore, the petal colour should be noted when fresh.

4. Zygophyllum simile *H. Eichler*, **sp. nov.**

Herba annua, usque ad 35 cm alta, glabra, basiramifera. Folia petiolata, unijugata; foliola carnosa, linearia vel anguste oblonga, 5–20 mm longa, ad basim articulata, ad apicem obtusa. Petala 4, alba, late obtrullata vel obovato-cuneata, 1–1.7 mm longa, apicem versus obscure trilobata vel irregulariter obtusa, sepalis semper breviora (plerumque ½–⅔ plo longiora). Stamina 8; filamenta basin versus sensim dilatata, haud appendiculata. Discus 4-partitus; lobi disci discreti, carnosi, oblongi, apice truncato papilloso. Capsula turbinata vel latissime obpyramidalis, 5–7 mm longa, tetragona, 4-cellularis, apice truncato; cellula 1- vel plerumque 2-seminalis.

HOLOTYPUS: *Hj. Eichler 17390*: South Australia. Far North-West. Musgrave Ranges. At the creek near the entrance to the Aboriginal Reserve between Mulga Park and Musgrave Park. 26° 03'S, 131° 18'E. 8 Sep 1963. (AD 96431090). ISOTYPI: B, CANB, K.

Glabrous annual, to 35 cm high, usually much-branched from the base; branches often spreading and ascending. *Leaves* petiolate, with one pair of leaflets; leaflets succulent, linear to narrowly oblong, 5–20 mm long, articulate at base, rounded at apex. Sepals 4, 2–3 mm long. *Petals* 4, white, broadly obovate-cuneate to obtrullate, 1–1.7 mm long, towards the apex almost 3-lobed or very blunt with irregularly wavy margin, distinctly shorter than sepals. *Stamens* 8; filaments gradually and sometimes irregularly broadened towards the base, without appendage. *Disc* 4-lobed; lobes free, succulent, oblong, truncate and papillose at apex. *Ovary* 4-celled, 4-angled, with the angles (at least in the lower part) papillose and the flat apex glabrous; style c. 0.5 mm long, stigma 4-lobed. *Capsule* turbinate to broadly reversed pyramidal, 5–7 mm long, 4-angled, 4-celled, truncate at apex, with 1 or usually 2 finely granular seeds per cell.

Widespread through temperate inland Australia; in all mainland States and southern Northern Territory. On sandy soils.

SELECTED SPECIMENS: NEW SOUTH WALES: North Western Plains: 10 km south of Enngonia along Mitchell Highway, *Hj. Eichler 22850*, 28 Sep 1981 (CANB); Lorne Station, Lightning Ridge, *D.F. Thompson 1900*, 4 Aug 1978 (NSW); Corella Station near Bourke, *H.F. Chilcott NSW 145387*, 27 Aug 1907 (NSW); Winbar Nature Reserve, *Hj. Eichler 22710*, 16 Sep 1978 (CANB); Cobar, *Haviland NSW 145381*, Jul 1911 (NSW). South Western Plains: Shuttleton, *W. Bäuerlen 3292*, Dec 1903 (NSW); Lake Cargelligo, *Rev. J.W. Dwyer NSW 145382*, Nov 1915. North Far Western Plains: 37 miles [59 km] from Wanaaring, *J.L. Boorman NSW 145384*, Oct–Nov 1912 (NSW); Tero Creek Stn, *P. Martensz 4141*, 4 Dec 1968 (CANB); 'Mount Mulyah', about 50 miles [80 km] north-west of Louth, grey-brown fine sandy loam, *C.W.E. Moore 4724*, 8 Dec 1966 (CANB); 7 km NE 'Mc Dougall's Well' homestead, 95 km NNW Broken Hill, *J.C. De Nardi 719*, 25 Sep 1971 (NSW); 36 miles [58 km] west of Wilcannia, *R.J. Hobson NSW 145386*, 20 Sep 1949 (NSW); Broken Hill, *I. Pidgeon & J. Vickery NSW 18742*, 22 Aug 1939. South Far Western Plains: Menindee, low sandy rise, *R.J. Stanley 2089*, 1 Aug 1978 (NSW); Kinchega National Park, *M. Fox 8402061*, 17 Feb 1984 (NSW); 22 miles [35 km] from Menindee to Ivanhoe, *H. Salasoo 5405a*, 22 Nov 1973 (NSW); 70 miles [112 km] south of Broken Hill, red sandy soil, *J.H. Leigh W57*, Oct 1966 (NSW); Mungo National Park, *M. Fox 8402144*, 19 Feb 1984 (NSW).

Z. simile strongly resembles *Z. ammophilum* in its habit. Among the Australian *Zygophyllum* species with truncate and 4-angled capsules, they are the only ones with white petals. *Z. ammophilum*, with which *Z. simile* has hitherto been confused, is characterized by its narrowly obovate to elliptical petals, 4 stamens, and usually 3 or 4 seeds per cell. Its distribution is restricted to south-eastern mainland Australia, where it often occurs together with *Z. simile*.

All four species described above were hitherto confused with *Z. ammophilum* F. Muell. *Z. angustifolium* and *Z. confluens* were, in addition, confused with *Z. billardierei* DC. When F. von Mueller described *Z. ammophilum*, he included, among the syntypes quoted, specimens of all four new species although they do not agree with his description. In order to define the application of Mueller's name indubitably, it seems appropriate to designate here a lectotype which agrees with Mueller's description as follows:

Zygophyllum ammophilum F. Muell., Fragm. Phytogr. Austral. 11(99): 28 (Nov 1878). LECTOTYPUS: *F. Mueller s.n*: Lachlan River, Sept. 1878 (MEL 56877). ISOLECTOTYPI: MEL, NSW.

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Notes on the lichen flora of New South Wales I. New records

Gintaras Kantvilas

Abstract

Kantvilas, Gintaras (Tasmanian Herbarium, GPO Box 252C, Hobart, Australia, 7001) 1990. Notes on the lichen flora of New South Wales I. New records. Telopea 4(1): 19–31. Thirty lichen taxa previously unrecorded for New South Wales are reported. Data on their diagnostic features, taxonomy, distribution and ecology are provided.

Introduction

The number of taxa comprising the lichen flora of New South Wales is presently 819 (Filson 1988). However, this inventory is far from complete and has been compiled primarily from published accounts [see Weber & Wetmore (1972) and Kantvilas (1989) for bibliographies] and some herbarium records. Much of the State remains lichenologically unexplored and no systematic, regional or ecological study of this flora has yet been undertaken. In view of the very wide range of habitats and vegetation types represented, including sclerophyll forests, cool temperate to subtropical rainforests, heathlands, deserts, mangroves and Australia's highest mountains, it is likely that many additional species will be discovered as further field studies are undertaken.

The present paper deals with 30 lichens previously unrecorded for New South Wales in the literature. The species were collected mainly in the north of the State in cool temperate rainforest dominated by *Nothofagus moorei*. Supplementary records were obtained from the large and historically significant lichen collection in the National Herbarium of New South Wales in Sydney.

Methods

Identification of specimens is based on comparisons with type or reliably identified reference material. Chemical analyses follow the standard procedures of White & James (1985). The depth of treatment of each taxon in the text has been determined by the extent to which reliable, current descriptions are readily available in other published sources, e.g. Galloway (1985) for New Zealand.

Species

1. Arthothelium ampliatum *(Knight & Mitten) Müll. Arg.*, Bull. Herb. Boissier 2, App. 1: 85 (1894).
Arthonia ampliata Knight & Mitten, Trans. Linn. Soc. Lond. 23: 106 (1860).

LECTOTYPE (fide Galloway 1985): New Zealand, ? Auckland, *Charles Knight* 276, 1858 (BM!).

Thallus crustose, thin, smooth to cracked, greenish grey, with a thin, black marginal prothallus. Apothecia black to black-brown, adnate, roundish or ± elongate, to c. 1 mm diam. Epithecium brown, K+ olive-grey. Hymenium pale olive-green, K- or ± pale olive-yellow, I+ reddish brown. Spores 8 per ascus, clavate to oblong-ellipsoid, occasionally somewhat curved, 30–37 x 10–14 µm, terminal cell undivided, markedly enlarged, 10–14 µm diam., 'tail' muriform.

A. ampliatum is apparently rare in New South Wales where it is recorded from the twigs of *Nothofagus moorei*. It is also known from New Zealand, Tasmania and Victoria, and is easily distinguished from other New South Wales species of *Arthothelium* by its spores (see Figure 1d) which resemble those of *A. dictyosporum* (Coppins & James) Coppins (see Coppins & James 1979). Although Galloway (1985) considered *A. infuscata* (Krempelh.) Müll. Arg. to be a synonym of *A. ampliatum*, that species (type specimen in M examined) has different spores and is identical with *A. interveniens* (see below). The type specimen of *A. ampliatum* consists of five pieces of bark mounted on a sheet with drawings of habit and anatomy. The uppermost central portion has a K+ magenta epithecium and is another species of *Arthothelium*, possibly *A. spadiceum* (Knight) Müll. Arg.

SPECIMEN EXAMINED: Northern Tablelands: Gloucester Tops, 1150 m, *Kantvilas* 418/88, 2.7. 1988 (HO, NSW).

2. Arthothelium ilicinum *(Taylor) P. James*, Lichenologist 3: 97 (1965).
Arthonia ilicina Taylor, Flora Hibernica 2: 105 (1836).

Arthothelium ilicinum is characterised by adnate, rounded to irregularly angulose, blackish apothecia to 0.5 mm diam., macrocephalic spores, 26–32 x 9–13 µm, with (4–)6–7(–8) transverse septa, no longitudinal septa and walls to c. 1.5 µm thick (Figure 1e). This corticolous species has a bitemperate global distribution and appears to be rare in New South Wales.

SPECIMENS EXAMINED: Central Coast: Hornsby, *F.R.M. Wilson*, 9.1897 (NSW). Northern Tablelands: Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas s.n.*, 4.7.1988 (HO).

3. Arthothelium interveniens *(Nyl.) Zahlbr.*, Catal. Lich. Univ. 2: 127 (1924).
Arthonia interveniens Nyl., Acta Soc. Scient. Fennic. 12: 482 (1863).
Type: America septentrionalis 235b (H-NYL 5470!).

In external appearance, *Arthothelium interveniens* resembles *A. ilicinum* but is characterised by a K+ olive hymenium and by elongate-clavate spores, 22–35(–40) x 7–12(–14) mm, with (4–)6–7(–9) transverse septa and 0–1(–4) longitudinal septa, mainly across the central cells (Figure 1a). In New South Wales, the species is recorded in cool temperate rainforest from the shaded, smooth-barked trunks of *Doryphora sassafras*, *Lomatia* sp. and young *Nothofagus moorei*. It is also known from Tasmania, Victoria, New Zealand and North America.

A superficially similar, as yet unidentified species of *Arthothelium* has been recorded also. Like *A. interveniens*, this undetermined taxon has a K+ olive hymenium, but differs in having more elongate spores with somewhat more pointed apices and very few (0–1) longitudinal septa (Figure 1b). It occurs in similar rainforest habitats on *Doryphora*, *Nothofagus*, *Orites* and *Elaeocarpus* and may be sympatric with *Arthothelium interveniens*.

SPECIMENS EXAMINED: North Coast: Antarctic Beech Walk, Wiangerie Forest Drive, Tweed Range, 1000 m, *Kantvilas* 648/88, 3.8.1988 (HO, NSW). Central Coast: Hornsby Junction, *Wilson*, 9.1897 (NSW). Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 284/88, 342/88, 30.6.1988 (HO, NSW).

Figure 1. Spores of *Arthothelium* species from New South Wales: **a.** *A. interveniens* [*Kantvilas* 284/88 (HO)]. **b.** *A.* cf. *interveniens* [*Kantvilas* 164/88 (HO)]. **c.** *A. velatius* [isolectotype (NSW)]. **d.** *A. ampliatum* [left: *Kantvilas* 418/88 (HO), right: lectotype (BM)]. **e.** *A. ilicinum* [*Kantvilas*, Barrington Tops *s.n.* (HO)].

Undetermined taxon (cf. *A. interveniens*):

Northern Tablelands: Mt Allyn Forest Park, start of track to Burraga Swamp, 980 m, *Kantvilas* 164/88, 28.6.1988 (NSW, HO); Burraga Swamp, 1000 m, *Kantvilas* 227/88, 29.6.1988 (NSW, HO); Gloucester Tops, 1150 m, *Kantvilas* 417/88, 2.7.1988 (NSW, HO); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 452/88, 4.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 487/88, 6.7. 1988 (HO, NSW).

4. Arthothelium velatius *Müll. Arg.* Bull. Herb. Boissier 1: 60 (1893).

Type: 'corticola, ad Bloomfield: *Wilson* 936, ad Oakleigh: *Wilson*, 1586, 1705'. Lectotype (selected here): Victoria: Oakleigh, on *Casuarina*, *F.R.M. Wilson* 1586, 1892 (G!). Isolectotype: Oakleigh, on tree, *Wilson* 1586, 8.8.1887 (NSW!). Syntypes: Victoria: Bloomfield, 1892, *Wilson* 936, 1892 (G!); Oakleigh, *Wilson* 1705, 1892 (G!); Oakleigh, on tree, *Wilson*, 8.8.1887 (MEL 11323).

Thallus thin, rather scurfy, pale mottled grey, lacking a prothallus. Apothecia black, epruinose, scattered, fleck-like, irregularly rounded or ± stellate-lobed, 0.2–0.4(–1.0) mm diam., ± immersed. Epithecium olivaceous black-brown, intensifying olive in K. Hymenium colourless, 45–70 µm thick. Asci clavate to broadly ellipsoid. Spores 8 per ascus, ellipsoid to clavate, sometimes slightly bent, (16.5–)26–37 x 8–13 µm, muriform, with 8–11 transverse and 2–3(–4) longitudinal septa across the widest part of the spore. Chemistry: thallus UV + pale yellow.

A. velatius is a distinctive corticolous species with muriform spores (Figure 1c), apparently rare or overlooked in New South Wales. All the specimens in G bear the date '1892' but this almost certainly refers to their date of receipt rather than Wilson's date of collection.

SPECIMEN EXAMINED: Central Tablelands: Bowral, *Wilson*, 9.1895 (NSW).

5. Catillaria tasmanica *Räsänen*, Suomal. Eläin-ja Kasvit. Seur. Van. Julk. 21: 3 (1944). Type: 'Tasmania: prope Newtown Falls, corticola, *R.A. Bastow*, 18.3.1887' (G!).

Catillaria tasmanica is characterised by a thin, pale to dark grey crustose thallus and by black lecideine apothecia, dark brown-black or greenish black, K± greenish epithecium, mainly colourless hymenium and hypothecium, and hyaline, 1-septate spores, (17–)20–32(–38) x 9–14(–17) µm, with a distinct wall 0.8–1.5 µm thick.

The species is found on smooth bark on young twigs and saplings and appears to be uncommon in New South Wales, being confined mostly to forests above 1300 m. It typically forms mosaics with other crustose lichens such as *Thelotrema lepadinum*, *Tephromela atra* and species of *Lecidea* and *Graphis*. *Catillaria tasmanica* is known also from Tasmania where it is extremely abundant.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 286/88, 30.6.1988 (HO, NSW); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 443/88, 4.7.1988 (HO, NSW); along road from Scone to Barrington at intersection with Quarry Road, 1350 m, *Kantvilas* 467/88 *p.p.*, 4.7.1988 (HO). Southern Tablelands: Parkers Gap near Captains Flat, *Kantvilas s.n.*, 11.5.1986 (HO).

6. Chiodecton colensoi *(Massal.) Müll. Arg.*, Bull. Herb. Boissier 2 App. 1: 86 (1894). *Leucodecton colensoi* Massal., Bull. Soc. Nat. Moscou 36: 266 (1863).

Chiodecton colensoi is characterised by minute, clustered black apothecia immersed in thalline warts (c. 1–10 per wart), a black-brown, K+ olive-grey cupular exciple, narrowly fusiform, bent, 3-septate spores, 36–56 x 3–4 µm, and branched, prominent

paraphyses with pale brown, K+ olive-grey apices. The thallus is smooth and often has a pinkish tinge in the field but contains no chemical compounds detectable by t.l.c. A full description of the species is given by Galloway (1985).

Chiodecton colensoi appears to be common in cool temperate rainforest in the Barrington Tops region where it forms extensive thalli on smooth bark, particularly on *Doryphora sassafras* and *Elaeocarpus* sp. Associated lichens include *Megalospora melanodermia*, *Menegazzia eperforata* and species of *Parmelinopsis* and *Heterodermia*. A superficially similar species, differing mainly in having a K+ pale pink hypothecium and hymenium, has been recorded in this habitat as well (*Kantvilas* 620/88). *Chiodecton colensoi* is known also from Tasmania and New Zealand.

SPECIMENS EXAMINED: Northern Tablelands: Burraga Swamp, Mt Allyn Forest Park, 1000 m, *Kantvilas* 205/88, 29.6.1988 (HO, NSW); Gloucester Tops, 1150 m, *Kantvilas* 387/88, 2.7.1988 (HO, NSW); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 451/88, 4.7.1988 (HO, NSW). Southern Tablelands: Monga State Forest near Mongarlowe River, *Kantvilas s.n.*, 11.5.1986 (HO).

7. Coccotrema cucurbitula *(Mont.) Müll. Arg.*, Nuovo Giorn. Bot. Ital. 21: 51 (1889).
Pertusaria cucurbitula Mont. in Gay, Hist. Fis. Pol. Chile Bot. 8: 200 (1854).

This species is recognised by its rather thick, ± lumpy, pale cream or grey thallus, apothecia immersed in subglobose, apically perforate thalline warts to c. 1 mm wide, and by the presence of cephalodia which are mostly inconspicuous except in fresh thalli. Spores are simple, hyaline, 8 per ascus, 40–60 x 18–32 µm. A full description is given by Galloway (1985).

Coccotrema cucurbitula is an austral cool temperate taxon known from southern South America, New Zealand and Tasmania. It appears to be rare in New South Wales and is currently known only from *Nothofagus* forest where it is epiphytic on smooth bark. The species is chemically variable and may require subdivision in the future. Specimens from New South Wales contain stictic and constictic acids (major) ± norstictic acid (trace). In Tasmania, the species contains only stictic and constictic acids (Kantvilas unpublished data) whilst in New Zealand, stictic, norstictic and salazinic acids have been recorded (Galloway 1985). An additional undetermined, related taxon (also present in Tasmania) containing norstictic acid only has been recorded in *Nothofagus* forest in the New England National Park. *C. cucurbitula* is the fertile, non-isidiate counterpart of *C. porinopsis* (see below).

SPECIMENS EXAMINED: North Coast: N.S.W.–Qld border, terminus of Repeater Station Road, c. 2.5 km SW of Springbrook, 1020 m, *Kantvilas* 670/88, 4.7.1988 (HO, NSW). Northern Tablelands: Gloucester Tops, 1150 m, *Kantvilas* 376/88, 2.7.1988 (HO, NSW).

8. Coccotrema porinopsis *(Nyl.) Imshaug ex Yoshimura*, Misc. Bryol. Lichenol. Nichinan 6: 135 (1974).
Verrucaria porinopsis Nyl., J. Linn. Soc. Lond. Bot. 20: 68 (1883).

Thallus pale grey to cream-fawn, composed of densely crowded, erect isidia, simple or occasionally forked, 0.10–0.15 mm thick, 0.5–1 mm tall. Cephalodia abundant, ± plane to warted-lumpy, irregularly roundish, 0.4–0.6 mm wide. Apothecia immersed singly in subglobose, apically perforated warts to 1 mm diam., absent in New South Wales specimens. Chemistry: stictic, constictic, norstictic (trace) acids.

Coccotrema porinopsis is a Western Pacific species (Galloway 1985) also known in New Zealand and Tasmania. Although usually lacking apothecia which are diagnostic for the genus as a whole, this species is easily recognised by the presence of cephalodia, its thallus chemistry and isidiate, caespitose habit. The species is recorded from *Nothofagus moorei* in humid forest clearings, associated with *Lobaria isidiophora*, *Parmelinopsis horrescens* and crustose lichens.

SPECIMENS EXAMINED: North Coast: Tweed Range, Wiangerie Forest Drive, Antarctic Beech Walk, 1000 m, *Kantvilas* 646/88, 3.8.1988 (HO, NSW). Northern Tablelands: Burraga Swamp, Mt Allyn Forest Park, 1000 m, *Kantvilas* 235/88, 29.6.1988 (HO, NSW).

9. Collema fasciculare *(L.) Wiggers* var. **fasciculare,** Prim. Fl. Holstat.: 89 (1780). *Lichen fascicularis* L., Mant. Pl. 1: 133 (1767).

Collema fasciculare var. *fasciculare* is a cosmopolitan species [see Degelius (1954) and Galloway (1985) for complete descriptions] characterised by a dark olive-green to blackish, wrinkled, subcrustose thallus when dry, swelling markedly when wet to a prominent, gelatinous, ± globular cushion. The species occurs in the very wet microhabitats on understorey twigs and tree buttresses. It differs from *C. fasciculare* var. *microcarpum*, which also occurs in New South Wales (Degelius 1974), by the presence of numerous, large apothecia to 2 mm diameter which ± obscure the thallus, and by the absence of granular isidia.

SPECIMENS EXAMINED: Northern Tablelands: Gloucester Tops, 1150 m, *Kantvilas* 296/88, 2.7.1988 (NSW); Thunderbolts Lookout, Barrington Tops National Park, 1450 m, *Kantvilas* 428/88, 4.7.1988 (HO, NSW).

10. Collema flaccidum *(Ach.) Ach.*, Lichenogr. Univers.: 647 (1810). *Lichen flaccidus* Ach., Nov. Act. Reg. Acad. Sci. Holm. 16: 14 (1795).

In his monograph of the genus *Collema*, Degelius (1974) did not formally cite Australasian material of this northern hemisphere species due to a lack of fertile specimens. However, the collections from New South Wales (which are sterile also) accord closely with his published description (Degelius 1954) and with reference specimens from Europe. *C. flaccidum* is a broadly lobate, corticolous species with squamiform, laminal isidia, and is closely related to the more common species, *C. subflaccidum* (see below).

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 344/88, 1.7.1988 (HO, NSW). Central Tablelands: Jenolan, *Wilson*, 9.9.1897 (NSW L2243).

11. Collema subflaccidum *Degelius*, Symb. Bot. Upsal. 20: 140 (1974).

Collema subflaccidum is characterised by a broadly lobate, dark olive-green to blackish thallus with laminal, globular to terete isidia. Apothecia are rare, even on a world scale (Degelius 1974), but one specimen from New South Wales has occasional juvenile apothecia with faintly grey pruinose discs that lack mature spores. *C. subflaccidum* occurs typically on fibrous bark, particularly on the buttresses of *Leptospermum* and *Eucalyptus*, and is mostly associated with *Collema subconveniens* and species of *Psoroma* or *Parmeliella*. The species is cosmopolitan but has been commonly overlooked in Australia.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas & Jarman* 314/88, 30.6.1988 (HO, NSW); Barrington Tops, (no collector) 8.1981 (HO).

12. Degelia gayana *(Mont.) Arvidsson & D. Galloway*, Lichenologist 13: 44 (1981). *Parmelia gayana* Mont., Ann. Sci. Nat., Bot. 3: 58 (1849).

Degelia gayana is characterised by a broadly lobate, lead-grey thallus with a faintly striate upper surface and densely rhizinate, bushy lower surface (see Arvidsson & Galloway 1981). It is prominent on understorey twigs in wet forests and associates with other foliose lichens containing cyanobacteria, e.g. species of *Nephroma*, *Leioderma*,

Pseudocyphellaria, Parmeliella, Psoroma and *Sticta*. *Degelia gayana* is known also from Victoria, Tasmania, New Zealand, Tristan Da Cunha and southern South America.

SPECIMEN EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas & Jarman* 335/88, 1.7.1988 (HO, NSW).

13. Dimerella lutea *(Dickson) Trevis.*, Ric. 1st. Lomb. Sci. Lett. 13: 65 (1880).
Lichen luteus Dickson, Fasc. Pl. Cryptog. Brit. 1: 11 (1785).

Dimerella lutea is a cosmopolitan species recognised by its dull green-grey crustose thallus, bright orange, lecideine apothecia and hyaline, narrowly ellipsoid spores, 7–14 x 3–4 µm (see Galloway 1985). It occurs on bark, wood or, rarely, on rock, and is particularly common on tree fern trunks and eucalypt buttresses.

SPECIMENS EXAMINED: Central Coast: Stanwell Park, *Hamilton*, 6.1909 (NSW). Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 318/88, 30.6.1988 (NSW, HO, herb. Vezda); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 454/88, 4.7.1988 (HO, NSW). Central Tablelands: Leura, *Hamilton*, 11.1909 (NSW).

14. Fuscoderma amphibolum *(Knight) P.M. Jørg. & D. Galloway*, Lichenologist 21: 297 (1989).
Pannaria amphibola Knight, *T. N. Z. I.* 12: 369 (1880).

Fuscoderma amphibolum is a small, squamulose to subfoliose species with a ± scabrid, blue-grey upper surface, becoming brownish on storage, and coarsely granular, mainly marginal soredia. It is epiphytic, usually amongst bryophytes on *Nothofagus* trunks. A complete account of the species, under the name *Leioderma amphibolum*, is given by Galloway & Jørgensen (1987). *Fuscoderma amphibolum* also occurs in New Zealand, Tasmania and Argentina but fertile specimens are known only from the first region. It is rare in New South Wales where it appears to be at the limit of its range and is confined to high altitude forests above 1100 m.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 309/88, 30.6.1988 (HO, NSW); Gloucester Tops, 1150 m, *Kantvilas* 395/88, 2.7.1988 (HO, NSW).

15. Graphis anfractuosa *Esch.* in Martius, Fl. Brasil. 1: 86 (1833).
Lectotype (fide Hayward 1977): Caitété, Brasilien (M); isolectotype (G!).

Thallus crustose, thin, pale greyish white. Lirellae prominent, black, sparingly branched, mostly to 2 mm long. Exciple carbonised, closed below, labia convergent. Hymenium 120–145 µm thick, I-. Spores 8 per ascus, 9–10– locular, (30-)32–36 x 8–10 µm, I+ blue. Chemistry: no substances detected.

Graphis anfractuosa is apparently rare in New South Wales where it has been recorded from the twigs of *Doryphora sassafras* in cool temperate rainforest. The species is also known from tropical America (Wirth & Hale 1978), New Zealand (Hayward 1977) and Victoria (Filson 1987). The New South Wales specimen has somewhat shorter lirellae than the type, but this is attributed to its relative youth. The genus *Graphis* is very well-developed in the forests of New South Wales and several superficially similar species have been recorded. *G. anfractuosa* is characterised by a basally closed exciple and ≥9-locular spores, and by its thallus chemistry.

SPECIMEN EXAMINED: Northern Tablelands: Burraga Swamp, Mt Allyn Forest Park, 1000 m, *Kantvilas* 195/88, 20.6.1988 (HO, NSW).

16. Graphis librata *Knight*, T. N. Z. I. 16: 404 (1884).
Lectotype (fide Hayward 1977): New Zealand: *sine loco*, ? Wellington, *Charles Knight* 67: 23 (WELT!).

Graphis librata is closely related to *G. scripta* (L.) Ach. of the northern hemisphere and its relationships with the taxa in this species complex are discussed by Wirth & Hale (1978). It is characterised by the presence of norstictic acid, black, flexuose lirellae with a basally open exciple and convergent lips, and by (5–)7(–9) locular spores, 16–26(–31) x 6–9 µm. The species typically occurs on young trunks of *Nothofagus* or *Doryphora*. It is known also from Tasmania, New Zealand and Dominica, and further descriptive details are given by Hayward (1977) and Wirth & Hale (1978). In both New South Wales and Tasmania, *Graphis librata* co-occurs with a second species which is distinguished only by the absence of norstictic acid.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 295/88, 30.6.1988 (HO, NSW) (*G. librata* s.str.); Gloucester Tops, 1150 m, *Kantvilas* 422/88, 2.7.1988 (HO, NSW) (without norstictic acid). Central Tablelands: Mt Wilson, Blue Mts., *Kantvilas s.n.*, 8.5.1988 (HO) (without norstictic acid).

17. Leioderma pycnophorum *Nyl.*, Lich. Nov. Zel.: 47 (1888).

See Galloway and Jørgensen (1987) for a full description. *Leioderma pycnophorum* is a characteristic austral cool temperate lichen known from southern South America, Tristan da Cunha, New Zealand, Tasmania and Victoria. It appears to be very rare in New South Wales where it is recorded on the twigs of *Lomatia arborescens* beneath a broken *Nothofagus moorei* canopy. The species is associated typically with a very diverse assemblage of conspicuous macrolichens including *Degelia gayana*, *Stricta fuliginosa* and species of *Nephroma*, *Pseudocyphellaria* and the Collemataceae.

The genus *Leioderma* is well represented in New South Wales with two further species, *L. sorediatum* and *L. duplicatum* present mostly in warm temperate forests.

SPECIMEN EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas & Jarman* 336/88, 1.7.1988 (NSW).

18. Maronea constans *(Nyl.) Hepp*, Fl. Eur.: 771 (1860).
Lecanora constans Nyl., Mém. Soc. Natn. Sci. Nat. Cherbourg 3: 199 (1855).

Thallus thinly crustose to ± granular, pale grey-green to brown, lacking a prothallus. Apothecia lecanorine, to 0.6(–1.0) mm diam.; disc plane, dark reddish brown, epruinose; thalline margin thin, crenulate when young. Epithecium red-brown, K-; hymenium and hypothecium colourless. Paraphyses simple or occasionally forked near the apices. Spores numerous per ascus, ellipsoid with rounded apices, simple or spuriously 1-septate, 4–7 x 2–4 µm.

Maronea constans is a cosmopolitan species, recorded previously in Australia from Victoria, Tasmania and South Australia (Filson 1988). It typically occurs in open situations such as on trees in pasture, but it is rare in closed forests where it is confined to canopy twigs. Specimens from such sheltered sites may resemble *Tephromela atra*, a species which is frequently sympatric but differs in having larger apothecia and spores which are 8 per ascus.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 311/88, 30.6.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 635/88, 6.7.1988 (NSW).

19. Menegazzia eperforata *P. James & D. Galloway*, N. Z. J. Bot. 21: 194 (1983).

Menegazzia eperforata is well characterised by a green-grey to suffused brownish olive-green upper cortex which lacks the perforations typical of the genus, and by the

presence of slender isidia. It is the most common species of *Menegazzia* in cool temperate rainforest in New South Wales where it occurs on the lower trunks of *Nothofagus moorei* and other trees in moderate shade. It is associated frequently with the related perforate, sorediate species, *M. nothofagi*. *M. eperforata* also occurs in Tasmania where it is uncommon, and New Zealand and Lord Howe Island. A superficially similar, undescribed, isidiate species with scattered perforations has been collected in the Tweed Range (*Kantvilas* 639/88).

SPECIMENS EXAMINED: Northern Tablelands: New England National Park, c. 3 km west of Point Lookout, 1500 m, *Kantvilas* 659/88, 6.8.1988 (NSW); Cascade Creek near Wrights Lookout, New England National Park, 1300 m, *Kantvilas* 671/88, 6.8.1988 (NSW); Burraga Swamp, Mt Allyn Forest Park, 1000 m, *Kantvilas* 200/88, 29.6.1988 (NSW, HO); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 268/88, 30.6.1988 (NSW); Gloucester Tops, 1150 m, *Kantvilas* 367/88, 2.7.1988 (HO, NSW); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 436/88, 4.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 476/88, 6.7.1988 (HO, NSW). Southern Tablelands: Monga State Forest near Mongarlowe River, *Kantvilas s.n.*, 11.5.1986 (HO).

20. Nephroma australe *A. Rich.*, Voy. Astrolabe Bot. Pars 1: 31 (1832).

Nephroma australe is the only Australasian species of *Nephroma* containing a green photobiont (see White & James 1988 for complete description). It is common on understorey twigs in cool temperate rainforest and wet sclerophyll forest in Tasmania, New Zealand and Victoria but appears to have been overlooked in New South Wales. Associated lichens typically include *Degelia gayana*, *Nephroma helveticum* and species of *Pseudocyphellaria* and *Psoroma*.

SPECIMENS EXAMINED: Northern Tablelands: along road from Scone to Barrington at junction with Quarry Rd, 1350 m, *Kantvilas* 466/88, 4.7.1988 (HO, NSW); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 332/88, 1.7.1988 (HO, NSW).

21. Nephroma cellulosum var. **isidioferum** *J. Murray*, Trans. R. Soc. N.Z. 88: 385 (1960).

This taxon is recognised by its deeply faveolate, dark brownish to grey (blue-green when wet) upper surface, glabrous, bullate, cream-coloured lower surface, and brown to red-brown adnate apothecia. Terete to squamiform isidia on the ridges of the faveolae, along the lobe margins and fringing the apothecia distinguish it from *N. cellulosum* var. *cellulosum*. This lichen has not been recorded previously from Australia (White & James 1988) although it occurs in South America and New Zealand. The type variety, with which it usually co-occurs, is widespread in the cool temperate Southern Hemisphere.

SPECIMEN EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas & Jarman* 333/88, 1.7.1988 (HO, NSW, BM).

22. Parmelia salcrambidiocarpa *Hale*, Smithson. Contr. Bot. 66: 38 (1987).

Parmelia salcrambidiocarpa is recognised by its relatively elongate, sublinear lobes, marginal and laminal pseudocyphellae, dense rhizines often forming a fringe protruding from beneath the thallus margins, and by the presence of atranorin and salazinic acid (see Hale 1987 for a complete description). It is similar to *P. tenuirima*, a very common corticolous species in New South Wales, but differs in being more delicate and regularly lobed. Previously known only from Tasmania and New Zealand, its occurrence in New South Wales at high altitudes exclusively on *Nothofagus* is consistent with its ecology in Tasmania.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m,

Kantvilas 271/88, 30.6.1988 (HO, NSW, ANUC); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 455/88, 4.7.1988 (HO, NSW, ANUC).

23. Pertusaria novaezelandiae *Szatala*, Borbasia 1: 60 (1939).

Pertusaria novaezelandiae is best characterised by its thick, grey-white crustose thallus containing hypothamnolic acid (medulla K+ purple, UV+ white). It has prominent, apically sorediate verrucae containing immersed apothecia, with one spore per ascus, (52–)84–150×(14–)22–56 µm with walls 5–8 µm thick. It is very common in New South Wales, frequently being the dominant lichen on the canopy branches of *Nothofagus moorei* in cool temperate rainforest. It is the ecological analogue of *Pertusaria truncata*, a superficially similar species (8 spores per ascus, medulla KC+ pink) which occupies this habitat in rainforests in Tasmania and New Zealand. *P. novaezelandiae* is typically associated with *Parmelia tenuirima, Haematomma infuscum, Tephromela atra, Relicina filsonii* and species of *Usnea*. It also occurs in Tasmania and New Zealand.

SPECIMENS EXAMINED: Northern Tablelands: New England National Park, Cascade Creek near Wrights Lookout, 1300 m, *Kantvilas* 673/88, 6.8.1988 (HO, NSW); approximately 1 km east of Mt Allyn, 960 m, *Kantvilas* 183/88, 28.6.1988 (HO, NSW); Burraga Swamp, Mt Allyn Forest Park, 1000 m, *Kantvilas* 188/88, 29.6.1988 (HO, NSW); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 292/88, 30.6.1988 (HO, NSW) *Kantvilas* 343/88, 1.7.1988 (HO, NSW); Gloucester Tops, 1150 m, *Kantvilas* 388/88, 2.7.1988 (HO, NSW); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 440/88, 4.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 475/88, 6.7.1988 (NSW). New England National Park, c. 3 km west of Point Lookout, 1500 m, *Kantvilas* 660/88, 6.8.1988 (HO, NSW). Southern Tablelands: Monga State Forest near Mongarlowe River, *Kantvilas s.n.*, 11.5.1986 (HO).

24. Phaeographis exaltata *(Mont. & v.d. Bosch) Müll. Arg.*, Flora 65: 336 (1882). *Lecanactis exaltata* Mont. & v.d. Bosch, Pl. Junghuhn 4: 475 (1857).

Phaeographis exaltata is recognised by its thick, grey to creamish or olivaceous grey thallus, robust, prominent lirellae, usually with a conspicuous black or grey-pruinose disc, and consistently 6(–7)-locular, brownish spores, 22–38 x 10–12 µm. Its chemistry does not include any substances detectable by t.l.c. *P. exaltata* is very common in New South Wales on smooth shaded trunks in rainforest. It is a widespread pantropical lichen and further descriptive data are given by Hayward (1977) and Wirth & Hale (1978). An unidentified, superficially similar species with smaller spores and containing norstictic acid has been recorded in similar habitats (*Kantvilas* 669/88).

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 285/88, 30.6.1988 (HO, NSW); Gloucester Tops, 1150 m, *Kantvilas* 416/88, 2.7.1988 (HO, NSW); Thunderbolts Lookout, Barrington Tops National Park, 1350 m, *Kantvilas* 444/88, 4.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 489/88, 6.7.1988 (NSW); New England National Park, c. 3 km west of Point Lookout, 1500 m, *Kantvilas* 657/88, 658/88, 6.8.1988 (HO, NSW).

25. Phlyctis subuncinata *Stirton*, J. Linn. Soc. Lond. Bot. 14: 464 (1875).
Phlyctis wilsonii Müll. Arg., Bull. Herb. Boissier 1: 43 (1893).
Isotype: Victoria: Mt Macedon, on tree, *F.R.M. Wilson* 830, 9.5.1885 (NSW!).

Phlyctis subuncinata is common in New South Wales on smooth bark in humid, shaded forest habitats [see Galloway (1985) for a complete description]. Typical hosts include *Doryphora sassafras, Orites excelsa* and young *Nothofagus moorei*. Although most specimens are sterile, the species is recognised by its pale grey thallus containing stictic acid (K+ yellow, PD+ orange) with scattered, white, sorediate patches which typically

signify the location of immersed apothecia. However, a potentially confusing, unidentified species containing psoromic acid (PD+ yellow) (*Kantvilas* 661/88) is known from similar habitats.

SPECIMENS EXAMINED: Central Coast: Hornsby, *Wilson*, 9.1897 (NSW). Northern Tablelands: Mt Allyn Forest Park, start of track to Burraga Swamp, 980 m, *Kantvilas* 171/88, 28.6.1988 (HO, NSW); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 328/88, 30.6.1988 (NSW, HO); Gloucester Tops, 1150 m, *Kantvilas* 405/88, 2.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 490/88, 6.7.1988 (NSW).

26. Pseudocyphellaria rubella *(J.D. Hook. & Taylor) D. Galloway & P. James*, Lichenologist 12: 302 (1980).
Sticta rubella J.D. Hook. & Taylor, Hook. Lond. J. Bot. 3: 649 (1844).

This distinctive foliose species is recognised by its silky tomentose upper surface which is grey to brown when dry but bright green when wet, and by its yellow medulla and granular soredia (see Galloway 1988). It appears to be rare in New South Wales, although common in New Zealand and Tasmania in *Nothofagus* forest and related vegetation. It occurs on trunks and twigs in humid, brightly lit habitats such as in forest clearings.

SPECIMENS EXAMINED: North Coast: Tweed Range, Wiangerie Forest Drive, Antarctic Beech Walk, 1000 m, *Kantvilas* 642/88, 3.8.1988 (NSW). Northern Tablelands: along road from Barrington to Scone, at junction with Quarry Road, 1350 m, *Kantvilas* 460/88, 4.7.1988 (NSW); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas & Jarman* 331/88, 30.6.1988 (HO, NSW).

27. Psoroma asperellum *Nyl.*, Syn. Meth. Lich. 2: 24 (1863).

Thallus squamulose. Squamules discrete and ± dispersed, or imbricate, often on a thin black prothallus, flat or ascending, rounded, crenate, incised or lobulate, mostly <1 mm across, bright green when wet, pale greyish green when dry. Cephalodia usually abundant, pale blue-grey when wet, inconspicuous when dry, convex or flat and ± squamulose. Apothecia 0.5–1.5 mm diam. Disc pale orange-pink to orange-brown, plane to convex. Thalline margin crenulate, occasionally ± squamulose. Hymenium I+ brown-red. Spores simple, hyaline, ellipsoid, (14–)16–23 x 7–10 µm, with a minutely roughened, warted epispore.

Psoroma asperellum is typically corticolous amongst bryophytes on mature tree trunks in wet forests, and is commonly associated with *Pseudocyphellaria glabra* and *Sphaerophorus* spp. It appears to be occasional in New South Wales where it is known from *Nothofagus moorei* and *Bedfordia arborescens* but is common in Tasmania, Victoria and New Zealand [see Galloway (1985) for further descriptive data]. The species was described originally from South Africa. It is rather similar to *Psoroma pholidotoides*, a more common species in New South Wales with contiguous, ± coalescing squamules and spores with a smooth epispore and prominent ± rounded, apiculate apices.

SPECIMENS EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 305/88, 30.6.1988 (HO, NSW). Southern Tablelands: Parkers Gap near Captains Flat, *Kantvilas s.n.*, 11.5.1986 (HO).

28. Pyrenula galactina *(Shirley) Kantvilas*, Pap. Proc. R. Soc. Tasmn. 122: 66 (1988).
Pseudopyrenula galactina Shirley, Pap. Proc. R. Soc. Tasm. (1893): 219 (1894). Holotype: Tasmania: St. Crispins, on bark, *W.A. Weymouth* 113 (BRI!).

Pyrenula galactina is characterised by a rather thick, pale yellowish grey, UV+ dull orange-yellow thallus, ± immersed perithecia and pale brown, 4-locular spores, 14–22(–26) x 5–10 µm [see Kantvilas (1988) for a full description]. The species is known in New South Wales from a single collection from understorey twigs of

Nothofagus moorei in rainforest. This specimen accords closely with the type from Tasmania.

SPECIMEN EXAMINED: Northern Tablelands: Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 297/88, 30.6.1988 (HO, NSW).

29. Sticta limbata *(Sm.) Ach.*, Meth. Lich.: 280 (1803).
Lichen limbatus Sm. in Sm. & Sowerby, Engl. Bot. 16: 1104 (1803).

Sticta limbata is a cosmopolitan species characterised by a ± monophyllous, brown-grey thallus (tinged blue-green when wet), with pale fawn-brown tomentum on the undersurface and marginal and laminal pale blue-grey soralia [see Galloway (1985) for full description]. It occurs on understorey twigs and tree buttresses in very wet, humid, open forests, where it is associated with *Collema subconveniens, Nephroma cellulosum, Pseudocyphellaria crocata* and other lichens containing cyanobacteria. In Australasia, the species is known from New Zealand, Tasmania, Queensland and Victoria (Filson 1988).

SPECIMEN EXAMINED: Northern Tablelands: Thunderbolts Lookout, Barrington Tops National Park, 1450 m, *Kantvilas* 424/88, 4.7.1988 (NSW).

30. Trapeliopsis granulosa *(Hoffm.) H.T. Lumbsh*, in Hertel, Lecideaceae Exsiccatae Fasc. 5: 99 (1983).
Verrucaria granulosa Hoffm., Descr. adumbr. Pl. Lich.2: 21 (1794).

Thallus crustose, composed of minute, dark to pale green, contiguous granules, usually ± microphylline at margins, KC+ red, C+ red (frequently very faintly). Apothecia lecideine, to 0.8 mm diam., pale orange-brown to pink-brown with a paler proper margin. Spores simple, hyaline, ellipsoid, (8–)9.5–12 x 4.5–6 µm. Chemistry: gyrophoric acid.

See Coppins & James (1984) and Galloway (1985) for further descriptions. *Trapeliopsis granulosa* is a cosmopolitan species occurring mostly on rotting wood, humus or on tree buttresses. It is occasional in New South Wales on the buttresses of *Nothofagus moorei* in cool temperate rainforest, but it is probably overlooked elsewhere. Specimens from New South Wales are relatively poorly developed and mainly esorediate.

SPECIMENS EXAMINED: Northern Tablelands: New England National Park, c. 3 km west of Point Lookout, 1500 m, *Kantvilas* 656/88, 6.8.1988 (HO, NSW); Mt William, Barrington Tops National Park, 1400 m, *Kantvilas* 304/88, 30.6.1988 (HO, NSW); Gloucester Tops, 1150 m, *Kantvilas* 421/88, 2.7.1988 (HO, NSW); approximately 1 km west of Mt Banda Banda, 1050 m, *Kantvilas* 484/88, 6.7.1988 (HO, NSW).

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References

Arvidsson, L. & Galloway, D.J. (1981) *Degelia*, a new lichen genus in the Pannariaceae. *Lichenologist* 13: 27–50.

Coppins, B.J. & James, P.W. (1979) New or interesting British lichens III. *Lichenologist* 11: 27–45.

Coppins, B.J. & James, P.W. (1984) New or interesting British Lichens V.*Lichenologist* 16: 241–264.

Degelius, G. (1954) The lichen genus *Collema* in Europe. Morphology, taxonomy, ecology. *Symb. Bot. Upsal.* 13: 1–499.

Degelius, G. (1974) The lichen genus *Collema* with special reference to extra-European species. *Symb. Bot. Upsal.* 20: 1–215.

Filson, R.B. (1987) *A Census of the non-vascular plants of Victoria I: Lichens* (National Herbarium of Victoria: Melbourne)

Filson, R.B. (1988) *Checklist of Australian Lichens* 3rd Edition (National Herbarium of Victoria: Melbourne).

Galloway, D.J. (1985) *Flora of New Zealand Lichens* (Wellington: Government Printer)

Galloway, D.J. (1988) Studies in *Pseudocyphellaria* (lichens) 1. The New Zealand species. *Bull. Br. Mus. Nat. Hist. (Bot).* 17: 1–267.

Galloway, D.J. & Jørgensen, P.M. (1987) Studies in the lichen family Pannariaceae II. The genus *Leioderma* Nyl. *Lichenologist* 19: 345–400.

Hale, M.E. (1987) A monograph of the lichen genus *Parmelia* Acharius sensu stricto (Ascomycotina: Parmeliaceae). *Smithson. Contr. Bot.* 66: 1–55.

Hayward, G.C. (1977) Taxonomy of the lichen families Graphidaceae and Opegraphaceae in New Zealand. *New Zealand J. Bot.* 15: 565–584.

Kantvilas, G. (1988) A re-examination of John Shirley's collection of Tasmanian lichens. *Pap. Proc. R. Soc. Tasm.* 122: 59–67.

Kantvilas, G. (1989) A checklist of Tasmanian lichens. *Pap. Proc. R. Soc. Tasm.* 123: 67–85.

Weber, W.A. & Wetmore, C.M. (1972) Catalogue of the lichens of Australia exclusive of Tasmania. *Beih. Nova Hedwigia* 41: 1–137.

White, F.J. & James, P.W. (1985) A new guide to microchemical techniques for the identification of lichen substances. *Brit. Lich. Soc. Bull. (suppl.)* 57: 1–41.

White, F.J. & James, P.W. (1988) Studies on the genus *Nephroma* II. The southern temperate species. *Lichenologist* 20: 103–166.

Wirth, M. & Hale, M.E. (1978) Morden-Smithsonian expedition to Dominica: The Lichens (Graphidaceae). *Smithson. Contrib. Bot.* 40: 1–64.

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A new species and new combinations in *Melicope* (Rutaceae) in New South Wales

T.G. Hartley

Abstract

Hartley, T.G. (Australian National Herbarium, Division of Plant Industry, CSIRO, G.P.O. Box 1600, Canberra, A.C.T. 2601) 1990. A new species and new combinations in Melicope *(Rutaceae) in New South Wales. Telopea* 4(1): 33–35. *Melicope hayesii* T. Hartley is described as new and new combinations in *Melicope* are made for three species previously included in *Euodia*.

Melicope J.R. & G. Forster and *Euodia* J.R. & G. Forster are being revised. The notes that follow are provided so that the names are available for use in the forthcoming *Flora of New South Wales*. The new classification of *Melicope* and *Euodia* has been discussed by Hartley (1981) and Hartley and Stone (1989).

Melicope hayesii *T. Hartley,* **sp. nov.**

Arbor 5–18 m alta; ramulis et foliis glabris; foliis trifoliolatis, 6.5–16 cm longis; petiolo 2–6 cm longo; lamina foliolorum lateralium ovato-elliptica, anguste ovato-elliptica, elliptica, vel anguste elliptica lamina terminali elliptica vel anguste elliptica, 3.7–9 × 1.2–4 cm; inflorescentiis axillaribus, multifloris, 2.5–6 × 2.5–5 cm, axe et ramis glabris vel fere glabris, pedicellis glabris vel sparse et minute puberulis, 2–4.5 mm longis; floribus bisexualibus; petalis albis, abaxialiter glabris, adaxialiter in ½ proximali villosis, 3–3.5 mm longis, caducis; staminibus 4; gynoecio glabro; carpellis fructificantibus in ⅕ proximali connatis, divergentibus, c. 5 mm longis, endocarpio puberulo vel sparse pubescenti, persistenti.

TYPE: QUEENSLAND: Moreton District: Springbrook, Carricks Road near Purling Brook, *L.W. Jessup 466* (CANB, holotype; BRI, isotype, not seen).

Tree 5–18 m high; indumentum of simple trichomes. *Young branchlets* 2.5–3.5 mm wide, with the leaves glabrous; terminal bud glabrous or nearly so (sometimes unevenly clothed with stiff, appressed trichomes — apparently an abnormal condition). *Leaves* trifoliolate, 6.5–16 cm long; petiole 2–6 cm long, 0.8–1 mm wide; petiolule in lateral leaflets obsolete or up to 5 mm long, in terminal leaflet 1–9 mm long; leaflet blades subcoriaceous, in lateral leaflets ovate-elliptic to elliptic or narrowly so, in terminal leaflet elliptic or narrowly so, 3.7–9 × 1.2–4 cm, the base acute to attenuate, the midrib prominent to plane (sometimes with narrow median ridge) above, the main veins prominulous above, in terminal leaflet 12–16 per side, diverging from midrib at 60–70° angle, the apex acuminate. *Inflorescences* axillary, many-flowered, 2.5–6 × 2.5–5 cm, the peduncle 0.7–2 cm long, with the distal axis and branches glabrous or nearly so, the pedicels glabrous to sparsely and minutely puberulent, 2–4.5 mm long (3–5 mm long in fruit). *Flowers* bisexual; calyx glabrous or nearly so, 0.7–1 mm long, the sepals connate only at base, suborbicular, persistent in fruit; petals white, imbricate, villous in proximal ½ adaxially, otherwise glabrous, 3–3.5 mm long, becoming recurved distally, caducous after anthesis; stamens 4, 4–5 mm long, the filament with a few trichomes near base adaxially or glabrous, subulate to filiform at apex, the anther 1.5–2.3 mm long; disc with a few tufts of trichomes at top or glabrous; gynoecium glabrous, 3–4.5 mm long, the style including stigma 2–3.5 mm long, the stigma scarcely differentiated from style, 0.2–0.3 mm wide. *Fruiting* carpels connate in proximal ⅕, divergent, ellipsoid, about 5 mm long, the epicarp coriaceous, glabrous, the

endocarp cartilaginous, puberulent or sparsely pubescent, persistent. *Seeds* ovoid, about 3.5 mm long; funiculus broad, flattened.

DISTRIBUTION. South-east Queensland and north-east New South Wales; recorded from rainforest and margins; 140–900 m.

ADDITIONAL SPECIMENS EXAMINED: QUEENSLAND: Darling Downs District: The Head, near Killarney, *W.T. Jones*, Oct 1967 (CANB). Moreton District: Springbrook, *Clemens 42874* (A), *W.T. Jones C 21 SN 5552* (CANB), *Schodde 5597* (CANB); Portion 83 Tallebudgera, Upper Currumbin Creek, *W.J.F. McDonald 3288* (CANB). New South Wales: North Coast: Lamington National Park, *Floyd*, 25.5.1961 (Coffs Harbour); Nullum State Forest, *Hayes* (BRI); Whian Whian State Forest, *Constable*, 15.1.1953 (NSW), *Johnson & Constable*, 10.6.1957 (NSW), *W.T. Jones 1234* (CANB), *2989 SN 7714* (CANB), *Moriarty 707* (BRI, CANB), *Tracey C81 SN5610* (CANB), *Webb & Tracey*, 1953–58 (BRI, CANB), *Webb & White 2112* (BRI); Moonpah State Forest, *Hayes*, Jan 1956 (Coffs Harbour), 25.6.1958 (NSW); Coramba, *Boorman*, Nov 1912 (NSW); East Dorrigo, *W.T. Jones 4* (BRI), June 1946 (Coffs Harbour); between Thora and Dorrigo, *Salasoo 1891* (NSW); Dorrigo State Forest, *White 7557A* (BRI); Bellingen District, *Hewitt*, Apr 1946 (NSW); Bellinger River, *W. MacDonald 23* (MEL); Pine Creek State Forest near Repton, *Wells*, 19.9.1958 (NSW); Bellangry State Forest, *Hayes & Floyd*, 6.11.1958 (Coffs Harbour).

Melicope hayesii appears to be most closely related to *M. micrococca* (F.Muell.) T. Hartley, differing mainly in its ovate-elliptic to elliptic (as opposed to usually obovate) leaflet blades, its glabrous (as opposed to hirtellous) gynoecium, and its caducous (as opposed to usually persistent in fruit) petals.

The geographic range of *Melicope hayesii* is entirely within that of *M. micrococca*, and both species have been collected from similar habitats in Lamington National Park, Whian Whian State Forest, and Bellangry State Forest. Their flowering periods are about the same.

The epithet *hayesii* commemorates Harold C. Hayes, formerly rainforest botanist with the Forestry Commission of New South Wales.

Melicope elleryana *(F. Muell.) T. Hartley,* **comb. nov.**

Euodia elleryana F. Muell., Fragm. 5: 4 (1865).

Type: Queensland: Port Curtis District, Beddome Creek, *Thozet* (MEL, holotype).

Melicope micrococca *(F. Muell.) T. Hartley,* **comb. nov.**

Euodia micrococca F. Muell., Fragm. 1: 144 (1859).

Type: New South Wales: Central Coast, Cabramatta, *Woolls* (MEL, holotype).

Euodia micrococca var. *pubescens* Fraser & Vickery, Proc. Linn. Soc. New South Wales 62: 289 (1937).

Type: New South Wales: North Coast, Bellingen, *Fraser & Vickery*, 26.1.1936 (NSW, holotype).

Melicope vitiflora *(F. Muell.) T. Hartley,* **comb. nov.**

Euodia vitiflora F. Muell., Fragm. 7: 144 (1871).

Type: Queensland: North Kennedy District, Rockingham Bay, *Dallachy* (MEL, holotype).

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References

Hartley, T.G. (1981) A revision of the genus *Tetradium* (Rutaceae). *Gard. Bull. Singapore* 34: 91–131.

Hartley, T.G., & Stone, B.C. (1989) Reduction of *Pelea* with new combinations in *Melicope* (Rutaceae). *Taxon* 38: 119–123.

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New taxa and combinations in *Eucalyptus* and *Angophora* (Myrtaceae)

L.A.S. Johnson & K.D. Hill

Abstract

Johnson, L.A.S. & Hill, K.D. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1990. New taxa and combinations in Eucalyptus *and* Angophora *(Myrtaceae). Telopea 4(1): 37–108* . A number of new taxa are described at specific and subspecific rank, and other taxa are changed in status. New species are *Angophora robur, Eucalyptus brunnea, E. scias* (with three subspecies, subspp. *scias, apoda* and *callimastha), E. interstans, E. prava, E. nandewarica, E. retinens, E. volcanica, E. nobilis, E. triplex, E. ophitica, E. hypostomatica, E. magnificata, E. placita, E. ancophila, E. apothalassica, E. psammitica, E. stannicola, E. williamsiana, E. subtilior, E. bensonii, E. conjuncta, E. croajingolensis* and *E. olida*. New subspecies are described in *E. camphora* (subspp. *relicta* and *humeana*), *E. coolabah* (subsp. *excerata*), *E. populnea* (subsp. *bimbil*), *E. polyanthemos* (subsp. *vestita*), *E. paniculata* (subsp. *matutina*), *E. fergusonii* (subsp. *dorsiventralis*), and *E. robertsonii* (subsp. *hemisphaerica*). Taxa newly recognised at specific rank are *Angophora euryphylla, A. crassifolia, Eucalyptus aquatica, E. elliptica, E. dorrigoensis,* and *E. latiuscula*. Previously described species newly reinstated from synonymy are *E. praecox, E. coolabah, E. sparsifolia, E. robertsonii,* and *E. fergusonii*. Infraspecific taxa are reinstated and are treated as subspecies in *E. resinifera* (subsp. *hemilampra*), *E. amplifolia* (subsp. *sessiliflora*), *E. coolabah* (subsp. *arida*), and *E. radiata* (subsp. *sejuncta*, a new name for *E. radiata* var. *subplatyphylla*). Lectotypes are designated for *E. camphora, E. lactea* (= *E. praecox*), *E. dorrigoensis, E. coolabah, E. coolabah* var. *arida, E. ovalifolia* var. *lanceolata* (= *E. polyanthemos* subsp. *polyanthemos*), *E. nanglei* (= *E. paniculata* subsp. *paniculata*), *E. fergusonii, E. phellandra* (= *E. radiata* subsp. *radiata*), *E. australiana* (= *E. radiata* subsp. *radiata*), *E. radiata* var. *subexserta* (= *E. radiata* subsp. *radiata*), and *E. radiata* var. *subplatyphylla* (= *E. radiata* subsp. *sejuncta*). A new name *E. beyeriana* is provided for the taxon previously known as *E. beyeri*, the type of the latter being of hybrid origin.

Introduction

Recent studies in eucalypt systematics have brought to light a surprisingly large number of undescribed taxa (Brooker 1988, Brooker & Hopper in press). The taxa included here are a small selection of a large number that have been defined during an overall revision of the eucalypts (in progress). These are taxa occurring in New South Wales, which we need to publish in advance in order to validate names for use in the forthcoming second volume of the *Flora of New South Wales*. Additional new species from New South Wales are also being described by Johnson & Blaxell (in prep.). At this stage, *Eucalyptus* L'Hérit. and *Angophora* Cav. will be used in the traditional sense. The species are not allocated alphabetic codes according to the system of Pryor & Johnson (1971), since these are being completely revised. Species are treated in the order in which they occur in the revised classification developed from Pryor & Johnson during this work. We are acquainted with all the taxa and their relatives in the field.

Rare or threatened species are allocated conservation status codes according to the system of Briggs & Leigh (1988).

Terminology

The term 'stemonophore' is used throughout as a more acceptable Greek combination

than the Latin-Greek hybrid 'staminophore' (after Johnson & Briggs 1984).

The term 'calyptra' is used throughout in place of 'operculum' as traditionally used in *Eucalyptus*. The latter term has been used in *Eucalyptus* alone, whereas the former is the accepted term for the broadly homologous fused perianth structures occurring widely in Myrtaceae (Johnson & Briggs 1984, following McVaugh 1968).

The calyptra in all *Monocalyptus* taxa is described as 'appearing single' in reference to the actually complex nature and origin of this structure, to be discussed elsewhere.

Bark is described as 'persistent' in cases where it is not regularly shed, and 'smooth' when regularly shedding. The former includes 'stringybark', 'box' and 'ironbark' among other types, and the latter covers the 'gum' barks.

1. Angophora euryphylla *(L. Johnson ex G. Leach) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *Angophora costata* (Gaertn.) Britten subsp. *euryphylla* L. Johnson ex G. Leach, Telopea 2(6): 759 (1986).

TYPE CITATION: 'HOLOTYPE: NEW SOUTH WALES: Central Coast: 3 km NW. of Gibbs Place, Putty, *Pickard 1639*, 26.4.1971 (NSW).'

Tree to 25 m high. *Bark* smooth, shedding in small scales, pink, grey or cream. Juvenile leaves ovate or narrowly triangular, sessile, cordate, to 10 cm long, 4.5 cm wide. *Intermediate leaves* ovate, petiolate, cordate, to 20 cm long, 9 cm wide, setose in young coppice shoots. *Adult leaves* broad-lanceolate, 12–19 cm long, 2–4.5 cm wide; petiole 15–20 mm long. *Peduncle* 15–25 mm long, setose; pedicel 8–15 mm long, setose. *Buds* ovoid, 6–10 mm long, 6–11 mm diam. *Petals* 4–5 mm long, 5–6 mm wide. *Hypanthium* strongly ribbed. *Fruit* ovoid, 15–21 mm long, 14–20 mm diam.; disc depressed.

Distinguished from *A. costata* (Gaertn.) Britten by the larger fruit (to 17 mm long and diam. in *A. costata*), the longer pedicel (to 8 mm long in *A. costata*), the setose coppice leaves, and the broad-lanceolate adult leaves. The two are parapatric in the area of occurrence of *A. euryphylla*, and although a degree of intergradation occurs, the two retain their identities and are considered to be reproductively separated.

SELECTED SPECIMENS (from 10 examined): NEW SOUTH WALES: Central Coast: Old Convict Road, 20.1 km E of Howes Valley, *J. Campbell & J. Pickard 1199*, 26.7.1970 (NSW); Old Convict Road, 5.5 km due W of Paynes Crossing, *K. Hill 2784 & L. Stanberg*, 3.5.1988 (NSW, PERTH, BRI); 1 mile [1.6 km] N of Gibbs Long Swamp, NNW of Putty, *L.A.S. Johnson NSW 127674*, 14.11.1965 (NSW); Judge Dowling Range, 8 miles [12.8 km] NNW of Kulnura, *L.A.S. Johnson NSW 143619*, 17.10.1965 (NSW).

DISTRIBUTION: Restricted to a small area between Putty and Wollombi, and south along the Judge Dowling Range (Figure 1).

ECOLOGY: Locally frequent in closed woodland on shallow or skeletal soils on sandstone ridges.

CONSERVATION STATUS: Not considered to be at risk. Although distributed over a limited area, this species is locally abundant and much of the range lies within national parks and reserves.

2. Angophora crassifolia *(G. Leach) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *Angophora bakeri* C. Hall subsp. *crassifolia* G. Leach, Telopea 2(6): 766 (1986).

TYPE CITATION: 'HOLOTYPE: NEW SOUTH WALES: Central Coast: past St Ives towards

Terrey Hills on the Mona Vale road, *Leach 122*, 21 May 1975 (LTB). ISOTYPES: CANB, NSW, BRI, MEL.'

Tree to 15 m high. *Bark* persistent, grey, shortly fibrous. *Juvenile leaves* lanceolate, to 8.5 cm long, 3 cm wide. *Adult leaves* lanceolate, 7–11 cm long, 0.7–1.5 cm wide; petiole 6–10 mm long. *Peduncle* 15–25 mm long, usually setose; pedicel 10–15 mm long, usually setose. *Buds* globose, 5–6 mm long, 6–8 mm diam. *Petals* 3–4 mm long, 3–4 mm wide. *Hypanthium* smooth or slightly ribbed. *Fruit* ovoid, usually apically narrowed, 10–14 mm long, 9–14 mm diam.; disc flat, obscured by rim of hypanthium.

Distinguished from *A. bakeri* C. Hall by the coriaceous, lanceolate adult leaves, the lanceolate juvenile leaves, and the larger fruit (to 11 mm long, 12 mm diam. in *A. bakeri*) with longer pedicels (to 11 mm long in *A. bakeri*). The two taxa are allopatric, with no known interbreeding.

SELECTED SPECIMENS (from 18 examined): NEW SOUTH WALES: Central Coast: Tumbledown Dick, *W.F. Blakely & J.L. Boorman NSW 143467*, 14.2.1922 (NSW); 1 mile E of St Ives Showground, *M.I.H. Brooker 3312*, 28.12.1971 (CANB, NSW); Frenchs Forest, *C. Burgess B316*, 27.12.1973 (CBG, NSW); 1 mile SE of Killara railway station, *W.F. Blakely*, 18.7.1936 (NSW 143577); Castlecove, Ridge N of Sugarloaf Bay, *L.A.S. Johnson NSW 143474*, 8.7.1950 (NSW); Northbridge, E end of Upper Cliff Avenue, *L.A.S. Johnson 9044*, 30.12.1987 (CANB, NSW, PERTH).

DISTRIBUTION: Restricted to the Ku-ring-gai Plateau region, between Port Jackson and the Hawkesbury River (Figure 1).

ECOLOGY: Locally frequent, usually associated with remnants of Tertiary lateritic soils over siliceous Hawkesbury Sandstone.

CONSERVATION STATUS: 2VCa. Large populations of this species occur in Ku-ring-gai Chase National Park and nearby reserves, but their proximity to the Sydney metropolitan region means that these must be considered to be vulnerable.

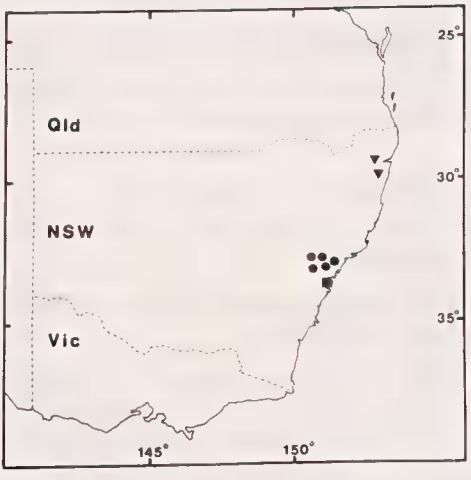

Figure 1. Distribution of *A. euryphylla* (circle), *A. crassifolia* (square) and *A. robur* (triangle).

3. Angophora robur *L. Johnson & K. Hill,* **sp. nov.**

Ab *A. subvelutina* foliis alabastris fructibusque majoribus et pedicellis longioribus distinguitur.

TYPE: NEW SOUTH WALES: North Coast: 1.3 km N of Kremnos Creek on Glenreagh--Grafton road, *K. Hill 787 & L. Johnson,* 7.5.1984 (holo NSW).

Tree to 10 m high. *Bark* persistent throughout, grey, shortly fibrous. *Juvenile leaves* narrow-oblong, to 10 cm long, 2 cm wide. *Adult leaves* broad-lanceolate to ovate, cordate, apically acute or acuminate, scabrid with short bristle glands, 7–18 cm long, 3–7.5 cm wide; petiole 0–1 mm long. *Peduncle* 15–35 mm long, setose; pedicel 7–15 mm long, setose. *Buds* globose, c. 10 mm long, 10 mm diam. *Hypanthium* ribbed. *Fruit* ovoid or campanulate, sometimes apically narrowed, 12–16 mm long, 12–16 mm diam.; disc flat, often obscured by rim of hypanthium.

A. robur is distinguished from *A. subvelutina* F. Muell. by the much larger adult leaves, buds and fruit (adult leaves to 9 cm long, 4 cm wide, buds to 7 X 7 mm, fruit to 11 X 11 mm in *A. subvelutina*). *A. robur* is also generally a smaller, more gnarled and twisted tree than *A. subvelutina*. Leaves, buds and fruit resemble those of *A. hispida* (Sm.) Blaxell in gross features of size and shape. The latter however has thicker leaves with more strongly differentiated upper and lower surfaces and rounded apices, and a thinner, more scaly bark. The habit is also more that of a shrub or mallee, whereas *A. robur* is always clearly a tree with a well-defined bole. Intergrades occur with *A. subvelutina* and *A. woodsiana* Bailey where ranges adjoin.

SELECTED SPECIMENS (from 5 examined): NEW SOUTH WALES: North Coast: 6 km S of Halfway Creek on Pacific Highway, *D.F. Blaxell 1850 & L.A.S. Johnson,* 22.4.1981 (NSW); 2 km E of Copmanhurst on Grafton road, *K. Hill 794 & L. Johnson,* 7.5.1984 (NSW); 6.7 km N of Glenreagh on Grafton road, *M.I.H. Brooker 6101,* 25.1.1979 (CANB, NSW).

DISTRIBUTION: Locally frequent but restricted, occurring sporadically in a band of country running from north-west of Coffs Harbour, around Glenreagh, to north-west of Grafton, in the Coaldale district (Figure 1).

ECOLOGY: Restricted to dry sclerophyll woodland on shallow or skeletal soils on highly siliceous sandstone phases of the Cretaceous Grafton Formation.

The epithet is from the Latin *robur,* 'an oak-tree' (one sense of the Latin word), referring to the appearance of the spreading trees of this broad-leaved species.

CONSERVATION STATUS: 3V-. The poor sandstone outcrop habitat of this species would not be under immediate direct threat from pastoral activity.

4. Eucalyptus brunnea *L. Johnson & K. Hill,* **sp. nov.**

Ab *E. deanei* characteribus sequentibus differt: folia nitidiora maculis grandibus distinctioribusque abaxialiter instructa.

TYPE: NEW SOUTH WALES: Northern Tablelands: 2.3 km N of Torrington on Silent Grove road, *R. Coveny 5192,* 7.9.1973 (holo NSW).

Tree to 35m high. *Bark* smooth, grey, yellow, orange or brown, shedding in broad, short ribbons, with a persistent scaly stocking to 1–2 m. *Seedling leaves* opposite for 4–6 nodes, petiolate. *Juvenile leaves* disjunct, ovate to orbicular, to 7 cm long, 7 cm wide; petioles to 1.1 cm long. *Adult leaves* disjunct, strongly dorsiventral, glossy dark green above, dull, pale, with distinct clusters of brown epidermal cells beneath, lanceolate to ovate, acute or acuminate, 7–14 cm long, 1.4–6.0 cm wide; petioles to 2.6 cm long; lateral veins closely to moderately spaced, regular, at 40–60° to midrib; reticulum even; oil glands large, closely spaced; intramarginal vein distinct, continuous, 0.5–2.0 mm

from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles terete or flattened, 7–14 mm long; pedicels terete, 2–5 mm long. Mature buds clavate, 6–8 mm long, 3–5 mm diam. *Calyptra* double, outer shed early, inner hemispherical, minutely apiculate, about half as long as hypanthium. *Fruit* cup-shaped, 3- rarely 4-locular, 5–7 mm long, 4–6 mm diam.; calyptra scar vertical, c. 0.5 mm wide; stemonophore raised, forming an elevated ridge around top of fruit, c. 0.5 mm wide; disc depressed at 20–70°, ultimately incurved, c. 1–2 mm wide; valves triangular, acute, basally enclosed, apically rim-level, raised at 60–90°.

E. brunnea differs from *E. deanei* Maiden in the more glossy adult and juvenile leaves with distinct brown epidermal markings abaxially, and the seasonally strongly-coloured brown bark (i.e. at certain stages in the shedding cycle). Juvenile leaves are more frequently orbicular and apically rounded, while those of *E. deanei* are more ovate, usually with a 'drip-tip'. Buds and fruit tend to have shorter, thicker pedicels and the calyptra is slightly shorter in *E. brunnea*.

SELECTED SPECIMENS (from 29 examined): QUEENSLAND: about E of Tannymorel on western slopes of Main Range, *S.T. Blake 19224*, 16.9.1953 (AAU, B, BISH, BRI, CANB, CHR, K, L, LE, MO, NSW, PR, PRE, SP); Thulimbah, *J.H. Simmonds*, 1.11.1910 (NSW); near South Bald Rock, 8 km ENE of Wallangarra, *L. Pedley A7414*, 21.2.1974 (NSW, BRI); Bald Rock (28°51'S 152°02'E), *M.D. Crisp 2529*, 24.5.1977 (CBG, NSW). NEW SOUTH WALES: Northern Tablelands: 9.1 miles [14.5 km] from Tenterfield towards Bald Rock, *M.I.H. Brooker 3949*, 2.3.1973 (CANB, NSW); Tenterfield to Sandy Flat, *J.H. Maiden*, 12.1898 (NSW); 19 miles [30.4 km] NE of Glen Innes, *D.J. McGillivray 2390 & L. Johnson*, 20.9.1966 (NSW).

DISTRIBUTION: New South Wales, north-eastern Northern Tablelands, from Wallangarra to Torrington and Ebor. Queensland, south-eastern Darling Downs, around Wallangarra (Figure 2).

ECOLOGY: Sporadic and scattered, locally abundant, in tall wet sclerophyll forests on wetter, sheltered sites and deeper, richer soils. Often associated with *E. caliginosa* Blakely, *E. radiata* Sieber ex DC. subsp. *sejuncta* L. Johnson & K. Hill and *E. andrewsii* Maiden or *E. campanulata* R. Baker & H.G. Smith.

The epithet is from the Late Latin *brunneus*, 'brown', in reference to the frequently brownish bark, and the vernacular name Brown Gum sometimes used for the species.

CONSERVATION STATUS: Not considered to be at risk.

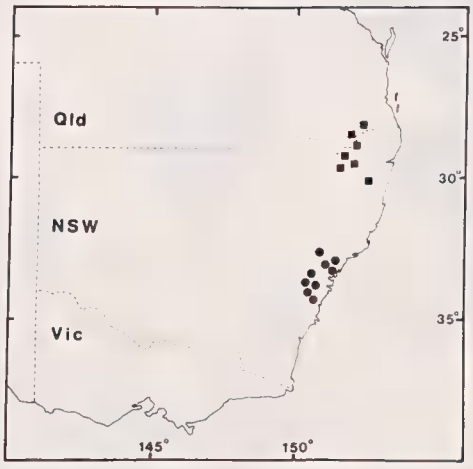

Figure 2. Distribution of *E. brunnea* (square) and *E. deanei* (circle).

5. Eucalyptus scias *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. pellita* characteribus sequentibus differt: folia adulta minora angustiora et distinctius dorsiventralia; pedicelli plerumque breviores; cortex fibrosior quasi 'stringybark' simulans.

TYPE: NEW SOUTH WALES: Central Coast: West Head, Ku-ring-gai Chase National Park (33°35'S, 151°18'E) *M.I.H. Brooker 3039 (FRI 20741)*, 5.5.1971 (holo NSW; iso CANB).

Tree to 20 m high, or mallee in exposed situations. *Bark* persistent throughout, fibrous, dark red-brown. *Seedling leaves* opposite for 3–5 nodes, lanceolate, petiolate. *Juvenile leaves* disjunct, broad-lanceolate to ovate, to 16 cm long, 10 cm wide; petioles to 2 cm long. *Adult leaves* disjunct, strongly dorsiventral, lanceolate, 7–15 cm long, 1.3–3.2 cm wide; petioles to 2.2 cm long; lateral veins closely spaced, regular at 50–70° to midrib; reticulum even; intramarginal vein distinct, continuous, 0.5–1.5 mm from margin. *Inflorescences* simple, axillary; umbellasters 3–7-flowered; peduncles flattened, 5–23 mm long, to 7 mm wide apically; pedicels angular or flattened, 0–9 mm long. *Mature*

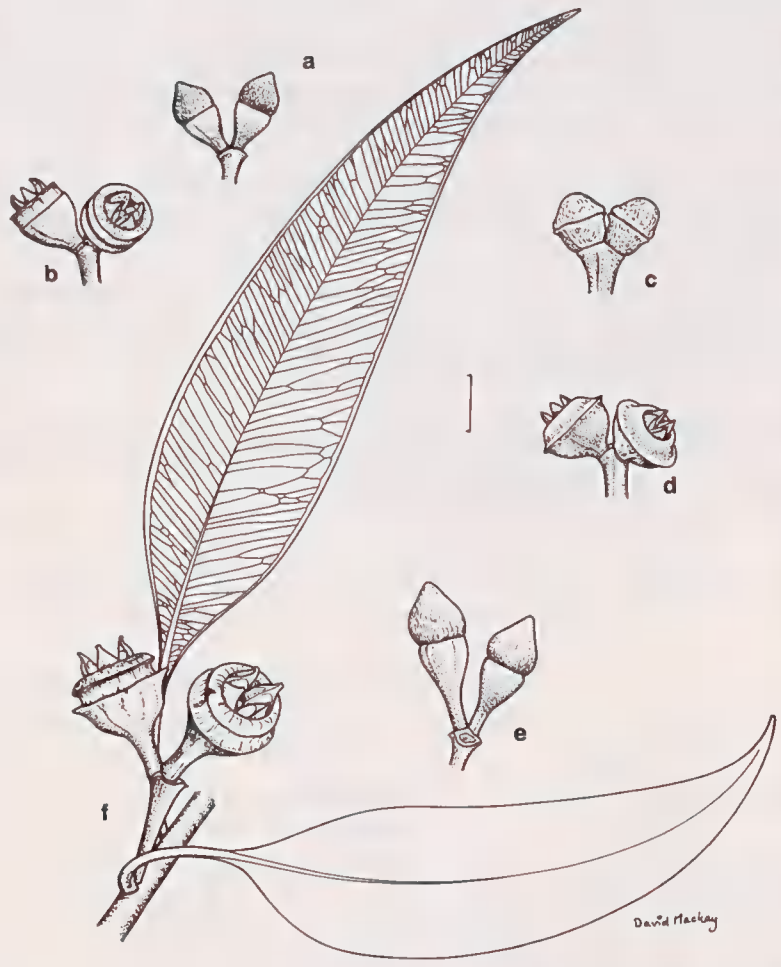

Figure 3. *E. scias*. **a.**, **b.**, buds and fruit of subsp. *callimastha* (from *W.A.W. de Beuzeville 550*). **c.**, **d.**, buds and fruit of subsp. *apoda* (from *K. Hill 1283 & L. Johnson*). **e.**, **f.**, buds, fruit and leaves of subsp. *scias* (from *J.L. Boorman, 10.1920*). Scale bar = 1 cm.

buds clavate to fusiform, 12–23 mm long, 8–14 mm diam. *Calyptra* double, outer shedding early, inner hemispherical to conical, rounded or apiculate to rostrate, half to twice as long as hypanthium, often wider than hypanthium. *Fruit* obconical to cup-shaped, 3–6-locular, 8–16 mm long, 9–20 mm diam.; calyptra scar expanded, sharply raised, 2–4 mm wide; stemonophore raised, less than 0.5 mm wide; disc sharply raised to flat, ultimately incurved, 1.5–3 mm wide; valves triangular, acute, basally deeply enclosed, apically exserted, raised at 60–90° (Figure 3).

E. scias differs from *E. pellita* F. Muell. in the smaller, narrower, more distinctly dorsiventral adult leaves (12–20 cm long, 3–5 cm wide in *E. pellita*) with shorter petioles (20–40 mm long in *E. pellita*), the smaller, narrower juvenile leaves (to 20 cm long in *E. pellita*), the more fibrous, almost stringy bark and the generally shorter pedicels (to 10 mm long in *E. pellita*). Adult leaves of *E. pellita* are also distinctly mucronate, with a pronounced 'drip-tip' that is lacking in *E. scias*.

E. pellita as now defined is restricted to north-eastern Queensland (type from Rockingham Bay, *J. Dallachy*, holo MEL).

DISTRIBUTION: New South Wales, sporadic and disjunct, usually in coastal ranges or hilly country, east of Tenterfield, and from Cessnock to Batemans Bay (Figure 4).

The epithet is from the Greek *skias*, 'a shade', in reference to the broad-leaved crown.

Three subspecies may be recognised on regional differences in bud and fruit morphology.

Key to subspecies

1 Calyptra conical .....5A. subsp. **scias**
1* Calyptra hemispherical
  2 Calyptra rounded .....5B. subsp. **apoda**
  2* Calyptra apiculate .....5C. subsp. **callimastha**

5A. Eucalyptus scias *L. Johnson & K. Hill* subsp. **scias**

Tree (sometimes several-stemmed) to 20 m high. *Adult leaves* green. *Peduncles* flattened, 6–16 mm long, to 7 mm wide apically; pedicels 2–9 mm long. *Mature buds* ovoid to fusiform, 14–23 mm long, 9–14 mm diam. *Calyptra* convex conical or rostrate, as long

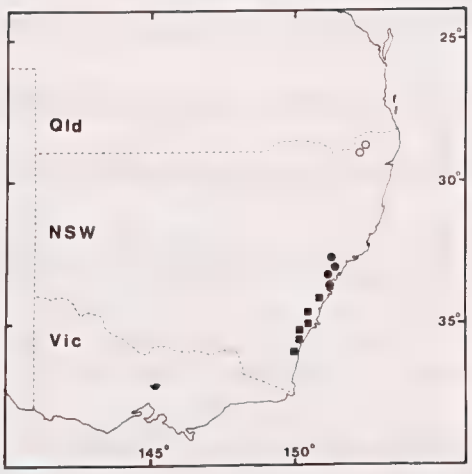

Figure 4. Distribution of *E. scias* subsp. *scias* (solid circle), subsp. *apoda* (open circle) and subsp. *callimastha* (square).

as or longer than hypanthium. *Fruit* cup-shaped, 4–6-locular, 8–16 mm long, 9–20 mm diam. *Calyptra* scar sharply raised, 2–4 mm wide; disc slightly raised or flat ultimately incurved, 2–4 mm wide. *Valves* narrowly triangular, acute, basally enclosed, apically exserted, raised at 45–90°.

SELECTED SPECIMENS (from 25 examined): NEW SOUTH WALES: North Coast: Pokolbin State Forest, 6 miles [9.6 km] SE of Broke, *R. Story 7374*, 8.5.1960 (NSW). Central Coast: Olney State Forest, *E.F. Constable NSW 10972*, 24.8.1949 (NSW); Jilliby Jilliby, W of Wyong, *J.L. Boorman*, 10.1920 (NSW); First Point, Kincumber, *J.H. Maiden & R.H. Cambage*, 17.6.1905 (NSW); South Creek, Narrabeen, *M.B. Welch*, 4.1932 (NSW); North Head, *R. Coveny*, 26.8.1967 (NSW).

CONSERVATION STATUS: Not considered to be at risk.

5B. Eucalyptus scias *L. Johnson & K. Hill* subsp. **apoda** *L. Johnson & K. Hill*, **subsp. nov.**

Folia alabastraque glaucescentia; calyptra longiuscula rotunda; pedunculus brevis; fructus sessiles.

TYPE: NEW SOUTH WALES: Northern Tablelands: 26.0 km from Bruxner Highway on Poverty Point road, E of Tenterfield, *K. Hill 1283, L. Johnson & J. Williams*, 10.9.1985 (holo NSW; iso BRI, CANB, K, PERTH).

Tree (sometimes several-stemmed) to at least 10 m high. *Leaves* and *buds* often glaucous, especially when dried. *Peduncles* flattened, 5–7 mm long, to 9 mm wide apically; pedicels angular, 0–2 mm long. *Mature buds* ovoid, 12–14 mm long, 8–10 mm diam. *Calyptra* oblong, hemispherical, rounded, slightly longer than hypanthium. *Fruit* sessile, obconical, 4–5-locular, 10–12 mm long, 10–16 mm diam. *Calyptra scar* vertically raised, 2–3 mm wide; disc slightly raised or flat, ultimately incurved, 2–3 mm wide. *Valves* narrowly triangular, acute, basally enclosed, apically strongly exserted, raised at 90°.

Subsp. *apoda* is distinguished from the other subspecies by the bluish leaves and buds, the oblong but rounded calyptra, the short peduncle and the sessile buds and fruit.

SELECTED SPECIMENS (from 5 examined): NEW SOUTH WALES: Northern Tablelands: Drake, *E.C. Andrews*, 6.1904 (NSW); Type locality, *K. Hill 1284, 1285 & L. Johnson*, 10.9.1985 (NSW); Parish Cavendish, County Clive, *R.J. Turner*, 22.10.1954 (NSW).

DISTRIBUTION: New South Wales, mountain ranges of far north-western North Coast, east of Tenterfield.

ECOLOGY: Sporadic and uncommon, usually on somewhat swampy sites on granite-derived soils.

The epithet is from the Greek *a-*, 'without', and *pous, podos*, 'a foot', in reference to the sessile buds and fruit.

CONSERVATION STATUS: 2V-. Known occurrences are in State Forest areas and possibly at some risk from forestry activities. Further study is required to establish population sizes and distributional limits.

5C. Eucalyptus scias *L. Johnson & K. Hill* subsp. **callimastha** *L. Johnson & K. Hill*, **subsp. nov.**

Folia adulta non vel vix glaucescentia; folia juvenilia lata; calyptra brevis mammiformisque; fructus cupuliformes, pedicellati; pedunculi longiusculi.

TYPE: NEW SOUTH WALES: South Coast: 7 km SSE of Batemans Bay (35°46'S, 150°13'E), *M.D. Crisp 6449*, 4.7.1980 (holo NSW; iso CBG).

Tree (sometimes several-stemmed) to 20 m high. *Adult leaves* green. *Juvenile leaves* ovate to orbicular, to 14 cm long, 10 cm wide. *Peduncles* flattened 8–23 mm long, to 5 mm wide apically; pedicels 2–5 mm long. *Mature buds* clavate to ovoid, 14–18 mm long, 9–12 mm diam. *Calyptra* hemispherical, rounded or shortly apiculate, slightly shorter than or as long as hypanthium. *Fruit* cup-shaped, 3–4-locular, 8–12 mm long, 9–14 mm diam. *Calyptra scar* sharply raised, 2–3 mm wide; disc slightly raised or flat, ultimately incurved, 2–3 mm wide. *Valves* narrowly triangular, acute, basally enclosed, apically exserted, raised at 45–90°.

Subsp. *callimastha* is distinguished from the other subspecies by the green adult leaves, the broad juvenile leaves, the short calyptra and the more cup-shaped, pedicellate fruit on longer peduncles.

SELECTED SPECIMENS (from 35 examined): NEW SOUTH WALES: Central Coast: Helensburgh, E of rubbish tip, *K. Mills*, 18.6.1985 (NSW); 4 km SW of Meryla Pass, *L. Johnson 8366*, 29.10.1977 (NSW). South Coast: 1.6 km S of Pigeon House (35°22'S 150°19'E), *M.D. Crisp 2509*, 1.5.1977 (NSW, CBG); Termeil, *W.A.W. de Beuzeville 550*, 10.8.1932 (NSW); 4 miles [6.4 km] N of Batemans Bay, *L. Walker 6*, 11.1917 (NSW).

DISTRIBUTION: Coastal New South Wales, from north of Wollongong to Batemans Bay.

ECOLOGY: Scattered in wet sclerophyll forests, usually on poorer soils and sometimes extending into coastal heath scrubs. Associated with *E. gummifera* (Sol. ex Gaertn.) Hochr., *E. maculata* Hook., *E. pilularis* Sm., *E. urceolaris* Maiden & Blakely, *E. globoidea* Blakely, and *E. botryoides* Sm.

The epithet is from the Greek *kallimasthos*, 'with beautiful breasts', in reference to the shape of the calyptra.

CONSERVATION STATUS: Not considered to be at risk.

6. Eucalyptus resinifera *Sm.* in White, Journ. Voy. New South Wales: 231, pl. 16 (1790)

TYPE CITATION: None cited.

TYPE: NEW SOUTH WALES: Port Jackson, *J. White* (holo BM).

Two geographic subspecies may be defined within *E. resinifera* (Figure 5). This excludes populations from northern Queensland, which are considered to constitute another taxon at specific rank, to be described in due course.

Key to subspecies

1 Calyptra less than 9 mm long, longest peduncle less than 15 mm long .....6A. subsp. **resinifera**

1* Calyptra more than 9 mm long, longest peduncle more than 15 mm long .....6B. subsp. **hemilampra**

6A. Eucalyptus resinifera *Sm.* subsp. **resinifera**

Peduncles 9–14 mm long. *Pedicels* 3–8 mm long. *Buds* 9–13 mm long; calyptra 6–9 mm long. *Fruit* 5–6 mm long, 5–7 mm diam.; calyptra scar and stemonophore usually less than 1 mm wide.

SELECTED SPECIMENS (from 62 examined): NEW SOUTH WALES: North Coast: Booral, *F.R. Rudder*, 2.1894 (NSW); Parish of Fens, Tea Gardens, *R. Carolin*, 2.9.1983 (NSW). Central Coast: 1 mile N of Freemans Waterholes, *G.M. Chippendale 460*, 30.5.1968 (NSW); Lindfield, *R. Baker*, 8.1900 (NSW); junction of Liverpool and Cabramatta roads, *J.L. Boorman*, 2.1900 (NSW); 5.1 km N of Menai turnoff on Heathcote Road, *R. Coveny 11163 & J. Thomas*, 14.7.1982 (NSW). South Coast: 6.4 km NW of Huskisson, *B.G. Briggs 3076, L. Johnson & D. Blaxell*, 15.12.1969 (NSW).

Intergrading forms between the two subspecies occur in the zone from Kempsey to Taree, although this species is not abundant in that region.

Intergrading populations with *E. notabilis* Maiden are known from the area between Colo Heights and Dural. Intersectional hybrids with *E. amplifolia* Naudin are known, as are intrasectional hybrids with *E. botryoides* Sm., *E. saligna* Sm. (the hybrid = *E. botryoides* Sm. var. *lynei* Blakely) and *E. propinqua* Deane & Maiden.

CONSERVATION STATUS: Not considered to be at risk.

6B. Eucalyptus resinifera *Sm.* subsp. **hemilampra** *(F. Muell.) L. Johnson & K. Hill,* **comb. et stat. nov.**

BASIONYM: *Eucalyptus hemilampra* F. Muell., J. Linn. Soc., Bot. 3: 85 (1859).

TYPE CITATION: 'Hab. Ad rivulos torrentesque sylvaticos secus partes fluvii Brisbane superiores. Anth. Dec., Jan.'

TYPE: Queensland: Upper Brisbane River, *F. Mueller* (holo MEL; iso K, NSW).

≡ *E. resinifera* Sm. var. *grandiflora* Benth., Fl. Austral. 3: 246 (1867).

Included in *E. resinifera* Sm. var. *grandiflora* Benth. by Bentham (1867); this in turn was included in *E. resinifera* by Maiden (*Crit. Revis. Eucalyptus* 3: 209 (1917)).

Peduncles 12–42 mm long. *Pedicels* 6–13 mm long. *Buds* 12–16 mm long; calyptra 10–12 mm long. *Fruit* 6–9 mm long, 6–8 mm diam.; calyptra scar and stemonophore usually more than 1 mm wide.

Distinguished from the type subspecies by the longer and more slender peduncles and pedicels, the slender, more strongly exserted valves, the relatively elongate fruit with a broad raised stemonophore and calyptra scar, and the longer calyptra.

SELECTED SPECIMENS (from 30 examined): QUEENSLAND: 25 miles [40 km] E of Gympie, on Cooloola Sandhills, *L.S. Smith 12131*, 13.5.1964 (BRI, NSW); Mt Coolum, *P.R. Sharpe 2726*, 10.10.1981 (BRI, NSW); Virginia, Brisbane, *S.T. Blake 4274*, 24.9.1932 (BRI, NSW); Water Island, *W.R. Petrie*. 8.1918 (NSW). NEW SOUTH WALES: North Coast: Acacia Creek, *W. Dunn*, 8.1906 (NSW); Girard State Forest, on Bruxner Highway, *K. Hill 813 & L. Johnson*, 9.5.1984 (NSW); Bucca

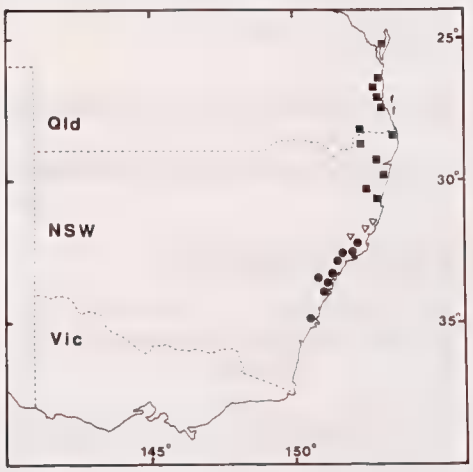

Figure 5. Distribution of *E. resinifera* subsp. *resinifera* (circle), subsp. *hemilampra* (square) and intergrading forms (open triangle).

Creek, Coffs Harbour, *J.L. Boorman*, 6.1911 (NSW); 2.5 km SE of Eungai Rail (31°52'S 153°55'E), *M.D. Crisp 7591 & J.M. Taylor*, 4.11.1984 (CBG, NSW).

CONSERVATION STATUS: Not considered to be at risk.

7. Eucalyptus interstans *L. Johnson & K. Hill*, **sp. nov.**

E. seeanam proxima sed characteribus sequentibus differt: folia juvenilia adultaque latiora; discus fructus angustus tandem valde incurvus; calyptra oblonga vel conico-obtusa; fructus majores.

TYPE: NEW SOUTH WALES: Northern Tablelands: Wilsons Downfall, *R.H. Cambage 2833*, 4.9.1911 (holo NSW).

Tree to 20 m. *Bark* smooth, patchy grey, pink, orange and brown. *Seedling leaves* oblong, petiolate, opposite for 3–5 nodes. *Juvenile leaves* disjunct, lanceolate to ovate-lanceolate, obtuse or acute, 5–14 cm long, 1–4 cm wide, petioles 5–25 mm long. *Adult leaves* disjunct, lanceolate, acute or acuminate, often falcate, 10–20 cm long, 1.0–3.5

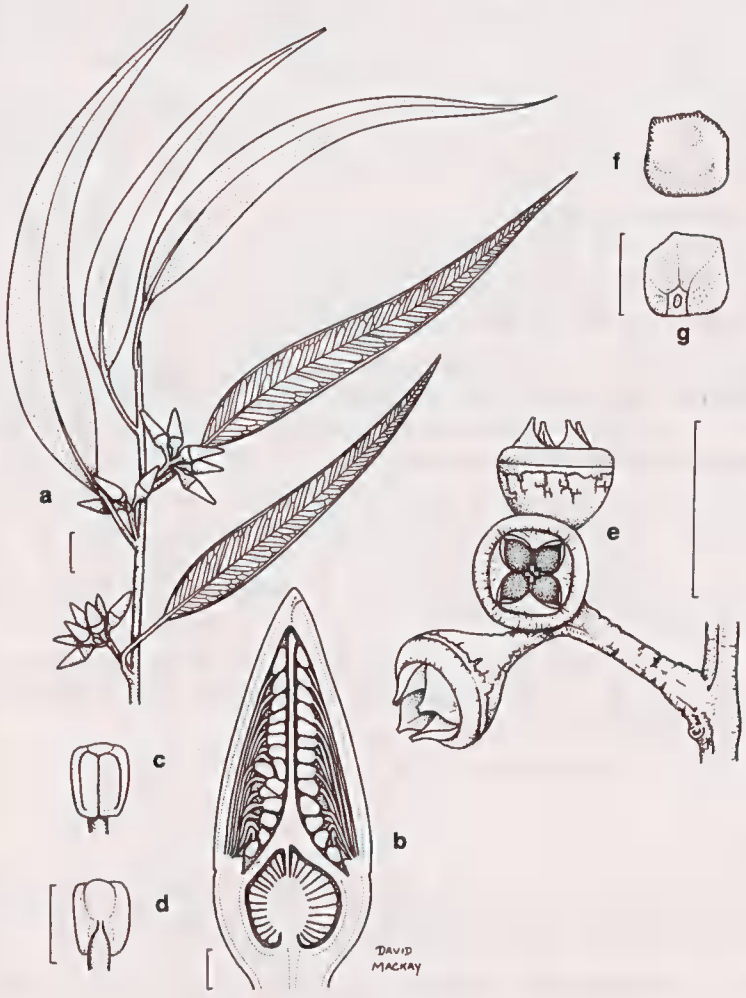

Figure 6. *E. interstans*. **a.**, shoot with buds. **b.**, median section of bud. **c.**, **d.**, anthers. E, fruit. **f.**, **g.**, seed (all from *K. Hill 816 & L. Johnson*). Scale bar: a, b = 1 cm; b,f,g = 1 mm; c,d = 0.5 mm.

cm wide; lateral veins well-spaced, irregular, reticulate between, at 45° to midrib; intramarginal vein distinct, 1–2.5 mm from margin; petioles 1.0–2.0 cm long. *Inflorescence* simple, axillary; umbellasters 7-flowered; peduncles terete or slightly angular, 10–15 mm long; pedicels angular, 3–5 mm long. *Mature buds* 9–13 mm long, 3–5 mm broad. *Calyptra* double, outer shed early, inner 2½–3½ times longer than hypanthium, oblong or conical, obtuse or sometimes acute, outer calyptra scar distinct. *Fruit* hemispherical or cup-shaped, 5–8 mm long, 5–9 mm diam., 3- or 4-locular, with vertically exserted, broadly triangular, often acuminate valves; calyptra scars forming a distinct band about 1 mm wide around top of hypanthium; disc narrow (to 1.5 mm wide), raised and ultimately strongly incurved and enclosing valve bases. *Seeds* dull, brown, cuboid, 0.6–0.8 mm long; chaff similar, longer and thinner (Figure 6).

E. interstans is distinguished from *E. seeana* Maiden by the lanceolate to ovate-lanceolate juvenile leaves, the lanceolate adult leaves, the narrow, ultimately strongly incurved disc (disc raised and often more than 1.5 mm wide in *E. seeana*), the oblong or conical, usually obtuse calyptra, and the larger fruit (to 5 mm long, 7 mm diam. in *E. seeana*). The juvenile leaves, although broader than those of *E. seeana*, are still lanceolate or ovate-lanceolate, and do not approach the broad-ovate juvenile leaves of *E. prava* L. Johnson & K. Hill. The buds and adult leaves are also intermediate in morphology between those of *E. seeana* and *E. prava*.

Populations intergrading with *E. prava* are known from the Stanthorpe–Wallangarra area in southern Queensland and northern N.S.W. Intergradation with *E. seeana* also occurs in the region east of Drake in northern N.S.W.

SELECTED SPECIMENS (from 19 examined): QUEENSLAND: Hellhole Gorge, near Crows Nest, *A. Bean 735*, 8.2.1988 (NSW); Cherry Gully, Dalveen to Warwick, *A. Bean 146*, 13.3.1985 (NSW). NEW SOUTH WALES: North Coast: 3.3 km E of Drake (28°56'S 152°24'E), *K. Hill 816 & L. Johnson*, 9.5.1984 (NSW, CANB, MEL); Tooloom, *R.H. Cambage 2896*, 8.9.1911 (NSW); 1.1 miles [1.8 km] W of Legume, *G.M. Chippendale 600 & R.D. Johnston*, 12.6.1968 (NSW).

DISTRIBUTION: South-eastern Darling Downs region of Queensland to the north-eastern Northern Tablelands and adjacent coastal ranges of New South Wales (Figure 7). The range of *E. interstans* occupies a zone lying between the ranges of *E. seeana* (a coastal species) and *E. prava* (a tablelands species).

ECOLOGY: *E. interstans* is restricted to sandy soils in drier sites, usually on ridges and slopes. The Hellhole Gorge occurrence is, however, on fairly level country with granitic outcrops above the gorge itself. *E. interstans* is often associated with *Angophora subvelutina* F. Muell., *Eucalyptus tereticornis* Sm., *E. crebra* F. Muell., *E. conica* Deane & Maiden, *E. moluccana* Roxb., *E. eugenioides* Sieber ex Sprengel and *E. maculata* Hook.

The epithet is from the Latin *inter*, 'between', and *stans*, 'standing', referring to the position of this taxon as an intermediate between *E. prava* and *E. seeana*, in both geographical and morphological senses.

CONSERVATION STATUS: Not considered to be at risk.

8. Eucalyptus prava *L. Johnson & K. Hill*, **sp. nov.**

Inter species *Bancroftianarum* combinatione calyptrae elongatae apice rotundatae, foliorum griseoglaucorum brevium latiusculorum saepe apice rotundatorum, innovationum alabastrorum pruinoso-glaucorum, distinguitur.

TYPE: NEW SOUTH WALES: Northern Tablelands: 2.3 km N. of Torrington on Silent Grove road, *R. Coveny 5190*, 7.9.1973 (Holo NSW).

= *Eucalyptus tereticornis* Sm. var. *brevifolia* Benth., Fl. Austral. 3: 242 (1867).

TYPE CITATION: 'New England, in very exposed situations in the mountains, *C. Stuart*.'

TYPE: NEW SOUTH WALES: New England, *C. Stuart* (holo K; iso MEL, NSW).

Included in *E. bancroftii* by Chippendale (1988).

[*E. tereticornis* Sm. var. *amblycorys* F. Muell. ex Maiden, Crit. Revis. Eucalyptus 2: 221 (1912), 4: 15 (1917), in part, in syn., nom. invalid.]

Specimens of *E. prava* and *E. parramattensis* C. Hall were distributed by Mueller under the manuscript name *E. tereticornis* Sm. var. *amblycorys*, which was never legitimately published or typified. Maiden also used the name '*E. brevifolia* Benth.' for *E. prava* in the same reference, but there is no evidence that Bentham published this name other than as a variety of *E. tereticornis*.

Tree to 15 m tall, usually less than 10 m, often of irregular habit. *Bark* smooth, grey with orange, white, grey-brown and dark grey patches, excorticating in large flakes. *Twigs* reddish, sometimes pruinose. *Cotyledons* reniform, 2 mm long, 3 mm wide. *Juvenile leaves* petiolate, disjunct, ovate, obtuse or rounded, to 13 cm long, 7.5 cm wide. *Intermediate leaves* smaller, ovate-lanceolate. *Adult leaves* ovate, ovate-lanceolate or broad-lanceolate, sometimes slightly falcate, acute, obtuse or rounded, disjunct, grey-green or glaucous, 4.5–12 cm long, 1.5–4.0 cm wide; lateral veins not regularly pinnate, reticulate between, at 45° or less to midrib; intramarginal vein distinct, 1.5–3.5 mm from margin; petiole 1.5–2.5 cm long, lamina slightly decurrent. *Inflorescence* simple, axillary; umbellasters 7-flowered, usually pruinose or glaucous; peduncles terete, 10–20 mm long; buds and fruit sessile, or pedicels up to 6 mm long. *Mature buds* 8–13 mm long, 3–6 mm diam. *Calyptra* double, outer shed early, inner 2–3½ times longer than hypanthium, oblong, apically rounded or obtuse, often glaucous. *Outer calyptra scar* distinct, outer calyptra often remaining on near-mature buds. *Fruit* rounded, 7–10 mm long, 6–10 mm diam., 3- or 4-locular with vertically exserted broadly triangular valves; calyptra scars forming a distinct broad band around upper ¼–½ of hypanthium; disc narrow, raised and ultimately incurved, enclosing valve bases. *Seeds* glossy, dark brown, angular, cuboid, 0.5 mm long; chaff similar, longer and narrower.

E. prava is distinguished in the series *Bancroftianae* by the combination of the elongate,

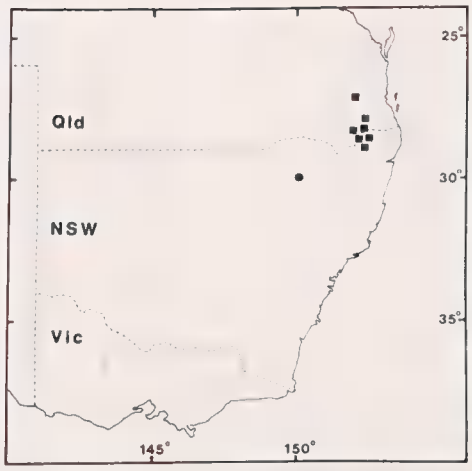

Figure 7. Distribution of *E. interstans* (square) and *E. nandewarica* (circle).

apically rounded calyptra, the greyish glaucous foliage with short, relatively broad and often apically rounded leaves, and pruinose-glaucous shoots and buds. Specimens of this taxon have been included under *E. bancroftii* (Maiden) Maiden, from which it differs in the foliage characters (adult leaves lanceolate and frequently more than 12 cm long) and the glaucousness.

Populations intergrading with *E. interstans* are known from the Stanthorpe–Wallangarra area in southern Queensland and northern N.S.W. Occasional hybrids between *E. prava* and *E. dealbata* A. Cunn. ex Schauer are also known in areas where the two intermingle.

SELECTED SPECIMENS (from 58 examined): QUEENSLAND: 16 km WSW of Stanthorpe, *L. Pedley 4139*, 30.9.1973 (BRI, NSW); Wyberba, *C.T. White 9332*, 13.10.1933 (BRI, NSW). NEW SOUTH WALES: Northern Tablelands: 3 miles [4.8 km] S of Wallangarra, *J.T. Waterhouse 1494*, 29.8.1970 (NSW); 11 miles [17.6 km] from Torrington on Silent Grove road, *M.D. Crisp 7353*, 29.9.1984 (CBG, NSW); 1.9 km E of New England Highway on Sunnyside road (30°26'S 151°38'E), *M.I.H. Brooker 7281*, 2.3.1982 (CANB, NSW); 7.2 km N of Bendemeer, *K. Hill 1287 & L. Johnson*, 11.9.1985 (NSW). North Western Slopes: Howell, *R. Coveny 3918*, 13.12.1971 (NSW); 5 km E of Mt Lindesay on Barraba fire trail, *K. Hill 2110*, 27.8.1986 (NSW). Central Western Slopes: Paradise Rocks, Murrurundi, *K. Hill 1321*, 21.9.1985 (NSW).

DISTRIBUTION: Darling Downs region of Queensland, restricted to the 'Granite Belt' from Stanthorpe to Wallangarra, extending into New South Wales on the western parts of the Northern Tablelands and higher elevations of the North Western Slopes on the Nandewar Range and extreme north-east of the Central Western Slopes on the Liverpool Range (Figure 8).

A specimen in NSW bears the label 'Cooma Ck, at back of gaol, L. Boorman, Dec. 1914', but *E. prava* has not otherwise been reported from the Southern Tablelands, and the cited locality has been searched with negative results. In the absence of corroboration, this record must be taken as an error in labelling.

ECOLOGY: Usually restricted to rocky areas and skeletal soils on siliceous granite, acid volcanic rocks or, rarely, sandstone or conglomerate. A component of dry sclerophyll woodlands, often in association with *Eucalyptus andrewsii* Maiden and a stringybark (such as *E. stannicola* L. Johnson & K. Hill or *E. laevopinea* R. Baker). Other associates include *E. bridgesiana* R. Baker, *E. malacoxylon* Blakely and *E. albens* Benth. Populations

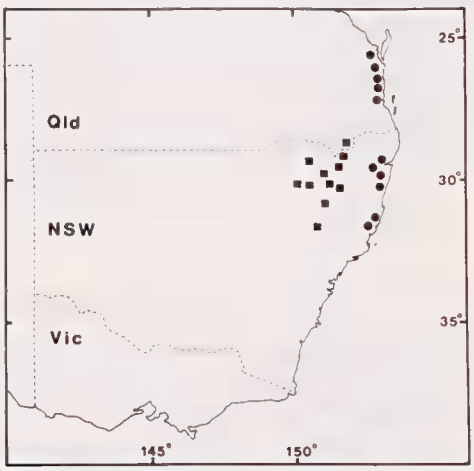

Figure 8. Distribution of *E. prava* (square) and *E. bancroftii* (circle).

through the western part of the Northern Tablelands are relatively continuous, with small outliers in the Liverpool and Nandewar Ranges.

The epithet is from the Latin *pravus*, 'crooked', referring to the general 'tumbledown gum' habit of the tree.

CONSERVATION STATUS: Not considered to be at risk.

9. Eucalyptus amplifolia *Naudin*, Descr. Emploi Eucalyptus, 2nd Mém.: 28 (1891).

TYPE CITATION: Naudin cited no specimens, but gave the following details of occurrences: 'Je l'ai trouvé dans plusieurs endroits de l'Algérie, dans nos jardins de Provence, dans celui de M. Hanbury, à la Mortola, près de Menton; j'en ai recu des échantillons de M. Ricasoli, de Florence et nous en possédons plusieurs exemplaires de différents ages à la villa Thuret.'

TYPE: Five specimens collected by Naudin from various localities in France and Italy and now housed at P may be regarded as Syntypes (n.v.).

Two geographically separated races have been identified in this taxon (Figure 9). These were separated as varieties by Blakely, although later authors did not accept this division (Pryor & Johnson 1971). We now consider the division to be justified, and recognise the two entities as subspecies.

Key to subspecies

1 Buds and fruit distinctly pedicellate .....9A. subsp. **amplifolia**
1* Buds and fruit sessile or subsessile .....9B. subsp. **sessiliflora**

9A. Eucalyptus amplifolia *Naudin* subsp. **amplifolia**

DISTRIBUTION: Widespread but patchy on the coastal plain of New South Wales from around Taree to Batemans Bay, with outliers north as far as Coffs Harbour and south to Bega. This taxon also occurs in the Megalong Valley and on the Southern Tablelands north-east of Goulburn (Figure 9).

ECOLOGY: Locally abundant or dominant on low-lying, often swampy alluvial soils on

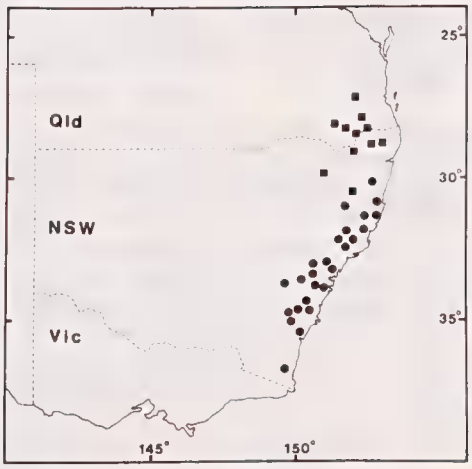

Figure 9. Distribution of *E. amplifolia* subsp. *amplifolia* (circle) and subsp. *sessiliflora* (square).

creek flats and sometimes on moist hillsides. *E. tereticornis* Sm. and, in tablelands areas, *E. blakelyi* Maiden are frequently associated with this taxon, but occurring on adjacent slightly higher and better-drained sites. Hybridism with these two species is often found in contact zones.

CONSERVATION STATUS: Not considered to be at risk.

9B. Eucalyptus amplifolia *Naudin* subsp. **sessiliflora** *(Blakely) L. Johnson & K. Hill,* **comb. et stat. nov.**

BASIONYM: *Eucalyptus amplifolia* Naudin var. *sessiliflora* Blakely, Key Eucalypts: 131 (1934).

TYPE CITATION: 'Acacia Creek, Macpherson Range (W. Dunn 47, December 1904, the type).'

TYPE: holo NSW.

Distinguished from the type subspecies by the consistently sessile buds and fruit.

SELECTED SPECIMENS (from 29 examined): QUEENSLAND: Portion 1564, Parish Emu Vale, County Merivale, *P. Holzworth* 2, 13.9.1983 (NSW); Cottonvale turnoff, Dalveen, *K. Hill 1254 & L. Johnson,* 29.8.1984 (NSW). NEW SOUTH WALES: North Coast: Mallanganee, *F.H.T. Ayton,* 9.1910 (NSW); Woodenbong, *D.J. McGillivray 306,* 24.8.1957 (NSW). Northern Tablelands: 1.8 miles [2.9 km] S of Tenterfield, *G.P. Smith 16,* 22.1.1971 (NSW); Chandler Run to Oakey Creek, E of Armidale, *A.W. Howitt,* 3.1903.

DISTRIBUTION: Southern Queensland and northern New South Wales, from around Crows Nest south to east of Armidale, and east to near Casino (Figure 9).

ECOLOGY: Apparently a widely tolerant taxon, most frequently on wetter sites with gravelly soils, although sometimes on more elevated and drier sites.

CONSERVATION STATUS: Not considered to be at risk.

10. Eucalyptus nandewarica *L. Johnson & K. Hill,* **sp. nov.**

E. dealbatae affinis sed characteribus sequentibus differt: folia juvenilia adultaque angustiora; alabastra fructusque minus vel non glauci; umbellastrae saepe triflorae.

TYPE: NEW SOUTH WALES: North Western Slopes: Waa Gorge, just upstream from twin pools, Mt Kaputar National Park (30°04'S, 150°06'E), *K. Hill 2113,* 28.8.1986 (holo NSW; iso BRI, CANB, K, PERTH).

Mallee or tree to 10 m high. *Bark* smooth, patchy white to dark grey, occasionally with a persistent fibrous stocking to 1–3 m. *Seedling leaves* opposite for 4–6 nodes, oblanceolate, petiolate. *Juvenile leaves* disjunct, lanceolate, obtuse or mucronate, to 11 cm long, 2.2 cm wide; petioles to 1.2 cm long. *Adult leaves* disjunct, similifacial, narrow- to broad-lanceolate, obtuse, acute or acuminate, 5–11 cm long, 0.8–2.0 cm wide; petioles flattened, 7–14 mm long; lateral veins closely to moderately spaced, irregular, at 30–50° to midrib; reticulum open, discontinuous; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 3–7-flowered; peduncles terete or angular, 4–8 mm long; pedicels terete or ribbed, 1–3 mm long. *Mature buds* ovoid to rhomboid, 6–8 mm long, 3–4 mm diam. *Calyptra* double, outer shed early, inner broadly conical, convex, obtuse or acute, 1.5–2.5 times as long as hypanthium. *Stamens* all fertile, filaments irregularly erect in bud, anthers elliptical, dorsifixed, versatile, dehiscing by parallel slits. *Fruit* cup-shaped to hemispherical, 3–4-locular, 4–5 mm long, 5–6 mm diam.; calyptra scar flat, continuous with stemonophore, the two less than 0.5 mm wide together; disc flat or slightly depressed

or domed, c. 1 mm wide; valves broadly triangular, obtuse, strongly exserted at 45–90°. *Seeds* semi-glossy, charcoal-black, angular, cuboid or pyramidal with dentate fringes, deeply loosely reticulate, c. 1 mm long; hilum ventral; chaff red-brown, semi-glossy.

E. nandewarica differs from *E. dealbata* A. Cunn. ex Schauer in the usually lanceolate juvenile and adult leaves, the generally non-glaucous buds and fruit, and the frequently 3-flowered umbellasters. Habitat preferences also differ, with *E. nandewarica* occurring on sandstones or siliceous volcanics, whereas *E. dealbata* tends to occur on more basic volcanic rocks in similar climatic situations. *E. dwyeri* Maiden & Blakely has similar juvenile leaves to those of *E. nandewarica*, although often narrower again, but differs in having distinctly larger fruit (more than 5 mm long, 6 mm diam.) with a flatter disc. It also has a more south-westerly range.

Variably glaucous populations occurring in parts of the Nandewar Range are thought to represent the result of hybridisation with *E. dealbata*.

SELECTED SPECIMENS (from 7 examined): NEW SOUTH WALES: North Western Slopes: Waa Gorge (30°04'S 150°06'E), *K.L. Wilson 6071*, 16.11.1984 (NSW); 5 km E of Mt Lindesay on Barraba fire trail (30°13'S 150°10'E), *K. Hill 2108*, 27.8.1986 (NSW).

DISTRIBUTION: North Western Slopes of New South Wales, on and around the Nandewar Range between Bingara and Barraba, and on slopes in the Warrumbungle Range (Figure 7).

ECOLOGY: Locally abundant or dominant on skeletal sandy soils over rocky sandstone or trachyte slopes.

The epithet refers to the Nandewar Range, where this species occurs.

CONSERVATION STATUS: 3RCa. Extensive populations occur within the Mt Kaputar National Park, and have also been reported from the Warrumbungle National Park.

11. Eucalyptus camphora *R. Baker*, Proc. Linn. Soc. New South Wales 24: 298, pl. 12 (1899)

TYPE CITATION: 'Hab. — It was first discovered by me at Ganguddy Creek, Kelgoola, Rylestone, in 1895, and afterwards in 1897 at Narango. It has since been found at Delegate (Hayden's Bog; W. Baeuerlen). It also occurs near Tumut.'

TYPE: A specimen from the Technological Museum Herbarium, Sydney (now held at NSW) bears the following annotations in Baker's handwriting: 'Ganguddy Creek Rylestone/R.T. Baker Sept. 1895/Material on which the sp. was founded/R. T. B.' This specimen is here designated the Lectotype. The locality is correctly spelt Rylstone.

This species comprises several disjunct groups of populations (Figure 10). These are morphologically distinguishable, and are recognised here as subspecies. The related taxon previously known as *E. ovata* Labill. var. *aquatica* Blakely is here recognised as a separate species (see below).

Key to subspecies:

1 Longest petioles less than 2 cm long .....11A. subsp. **camphora**
1* Longest petioles greater than 2 cm long
  2 Largest adult leaves less than 2.5 cm wide .....11B subsp. **relicta**
  2* Largest adult leaves more than 2.5 cm wide .....11C. subsp. **humeana**

11A. Eucalyptus camphora *R. Baker* subsp. **camphora**

Small tree. *Bark* persistent on lower trunk, hard, dark grey; smooth above. *Juvenile leaves* elliptical, to 11 cm long, 5 cm wide; petioles 2–2.5 cm long. *Adult leaves* broad-lanceolate to ovate or elliptical, sub-glossy, 5–10 cm long, 2.5–3.5 cm wide; petioles

9–17 mm long. *Peduncles* 4–11 mm long, 1.5–2 mm thick; pedicels 1–5 mm long. *Buds* turbinate, 6–7 mm long, 4–5 mm diam.; calyptra double, outer shed early, inner slightly shorter than hypanthium. *Fruit* obconical, mostly 3-locular, 4–5 mm long, 4–5 mm diam.; disc c. 1 mm wide, slightly raised then sharply depressed.

Distinguished from the other subspecies by the relatively short adult leaves with short petioles, the very short petioles on the juvenile leaves, and the small fruit.

SELECTED SPECIMENS (from 12 examined): NEW SOUTH WALES: Central Tablelands: Nullo Mountain, *R.T. Baker*, 28.8.1898 (NSW); Ganguddy Creek, 3 miles [4.8 km] E of Currant Mountain Gap, *L.A.S. Johnson NSW 17708*, 1.9.1951 (NSW); Blayney, Bathurst side of railway crossing, *C. Debenham*, 9.1969 (NSW); Megalong Creek, Megalong Valley, *L.A.S. Johnson NSW 24982*, 12.8.1953 (NSW).

DISTRIBUTION: Central Tablelands, from around Nullo Mountain south to the Megalong Valley. Subsequent searches of the Blayney locality have failed to locate this taxon. This may be due either to land clearing or to an erroneous annotation.

ECOLOGY: Sporadic and local, usually in small pure stands on swampy creek flats through the Central Tablelands.

CONSERVATION STATUS: Not considered to be at risk.

11B. Eucalyptus camphora R. Baker subsp. **relicta** *L. Johnson & K. Hill*, **subsp. nov.**

Inter subspecies *E. camphorae* foliis adultis parvis brevibusque petiolis longis, pedunculis longis et fructu majusculo distinguitur.

TYPE: QUEENSLAND: Girraween National Park, *N. Byrnes 4094*, 30.8.1982 (holo NSW; iso BRI, CANB).

Small tree or mallee. *Bark* persistent on lower trunk, hard, dark grey; smooth above. *Juvenile leaves* elliptical, to 13 cm long, 6 cm wide; petioles 2–2.5 cm long. *Adult leaves* lanceolate to broad-lanceolate, sub-glossy, 6–10 cm long, 1.8–2.4 cm wide; petioles 2–2.5 cm long. *Peduncles* 8–14 mm long, 1.5–2 mm thick; pedicels 3–6 mm long. *Buds* turbinate, 7–8 mm long, 4–5 mm diam.; calyptra double, outer shed early, inner

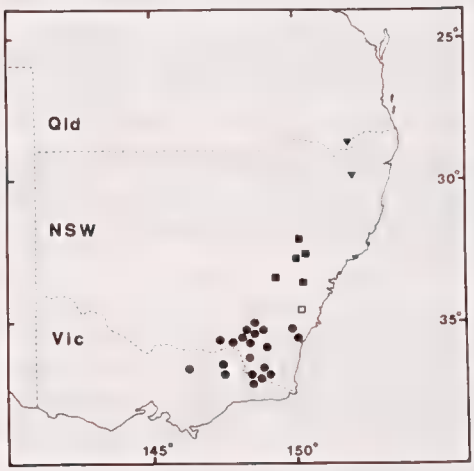

Figure 10. Distribution of *E. aquatica* (open square), *E. camphora* subsp. *camphora* (solid square), subsp. *relicta* (triangle) and subsp. *humeana* (circle).

slightly shorter than hypanthium. *Fruit* obconical, 3–4-locular, 6–8 mm long, 6–8 mm diam.; disc c. 1 mm wide, slightly raised then sharply depressed.

Distinguished by the small, short adult leaves with relatively long petioles, the long peduncles and pedicels and the large fruit.

SELECTED SPECIMENS: QUEENSLAND: Racecourse Creek, NE of Wallangarra, *L.S. Smith 754*, 29.1.1940 (BRI, NSW). NEW SOUTH WALES: Northern Tablelands: 0.5 miles [0.8 km] N of Sara River, c. 25 miles [40 km] SE of Glen Innes, *R.H. Squire*, 5.5.1969 (NSW).

DISTRIBUTION: An extremely restricted taxon, known from only three small stands on swampy creek flats, one in southern Queensland and two on the Northern Tablelands of New South Wales.

The epithet is from the Latin *relictus* 'left behind', referring to the probability that these northern populations derive from dismemberment of a formerly more continuous distribution.

CONSERVATION STATUS: 3V. Although this taxon spans a relatively wide geographic range, populations are small and isolated. The habitat is also under threat from eutrophication and grazing activity. The N.S.W. stands are at present in somewhat isolated State Forest land, and should be secure in the short term.

11C. Eucalyptus camphora *R. Baker* subsp. **humeana** *L. Johnson & K. Hill*, **subsp. nov.**

Inter subspecies *E. camphorae* foliis adultis juvenilibusque magnis longisque petiolis longis, pedunculis pedicellisque longis distinguitur.

TYPE: NEW SOUTH WALES: Southern Tablelands: 0.5 km S of Lobs Hole on Ravine Road, *K. Hill 739, L. Johnson & L. Pryor*, 27.4.1985 (holo NSW; iso CANB, MEL).

Small tree. *Bark* persistent on lower trunk, hard, dark grey; smooth above. *Juvenile leaves* ovate, often emarginate, to 7 cm long, 5 cm wide; petioles to 5 mm long. *Intermediate leaves* to 10 x 10 cm. *Adult leaves* broad-lanceolate to ovate or elliptical, sub-glossy, 8–15 cm long, 2.5–6 cm wide; petioles 1.8–3 cm long. *Peduncles* 5–15 mm long, less than 1.5 mm thick; pedicels 3–5 mm long. *Buds* turbinate, 5–7 mm long, 3–4 mm diam, calyptra double, outer shed early, inner slightly shorter than hypanthium. *Fruit* obconical, mostly 3-locular, 4–6 mm long, 4–6 mm diam.; disc c. 1 mm wide, slightly raised then sharply depressed.

Distinguished by the large, relatively long adult and juvenile leaves, the long petioles in adult and juvenile leaves, and the relatively long peduncles and pedicels.

SELECTED SPECIMENS (from 65 examined): NEW SOUTH WALES: Southern Tablelands: ¼ mile [0.4 km] E of Bondo Forestry settlement, *M.I.H. Brooker 2970*, 10.3.1971 (CANB, NSW); 2.5 miles [4.9 km] from Yarrangobilly towards Rules Point, *M.I.H. Brooker 2963* (CANB, NSW); Coree Flats, c. 1 mile [1.6 km] N of Mt Coree (A.C.T.), *R. Eakin 9*, 30.12.1969 (CANB, NSW); 7.2 km N of bridge over Goodradigbee River N of Brindabella, *G.M. Chippendale 824*, 10.2.1972 (CANB, NSW); Bago State Forest (Batlow district), *W.A.W de Beuzeville 641*, 15.1.1933 (CANB, NSW); Delegate, *W. Baeuerlen 39*, 1.1899 (NSW). VICTORIA: Bendoc, *W. Forsyth 3*, 5.1908 (NSW); 3 miles [4.8 km] N of Wulgulmerang Creek on north bank of Goodwin Creek, *R. Filson 8231*, 4.3.1966 (NSW, MEL); Mitta Mitta, *A. Meebold 21499*, 12.1936 (NSW); 42 miles [67 km] from Wodonga towards Bogong on Kiewa Valley Highway, *M.I.H. Brooker 4359*, 11.2.1974 (CANB, NSW).

DISTRIBUTION: A relatively abundant subspecies, occurring in small often pure stands on somewhat swampy sites on the Southern Tablelands of New South Wales, extending a short distance into north-eastern Victoria.

The epithet refers to Hamilton Hume (1797–1873), who explored and whose name is associated with the region in which the subspecies occurs.

CONSERVATION STATUS: Not considered to be at risk.

12. Eucalyptus aquatica (Blakely) L. Johnson & K. Hill, **comb. et stat. nov.**

BASIONYM: *Eucalyptus ovata* Labill. var. *aquatica* Blakely, Key Eucalypts: 140 (1934).

TYPE CITATION: 'N.S.W. — Wingello, A. Murphy, November, 1903.'

TYPE: NEW SOUTH WALES: Southern Tablelands: Wingello, *A. Murphy 6*, 11.1903 (holo NSW).

Mallee or small tree. *Bark* smooth throughout. *Juvenile leaves* elliptical, crenate, to 5 cm long, 3 cm wide; petioles 1–5 mm long. *Adult leaves* narrow-elliptical to elliptical, sub-glossy, 5–8 cm long, 1.5–3.5 cm wide; petioles 9–15 mm long. *Peduncles* 3–7 mm long, 2–3 mm thick; pedicels 1–3 mm long, to 2 mm thick. *Buds* turbinate, 6–7 mm long, 3–4 mm diam.; calyptra double, outer shed early, inner slightly shorter than hypanthium. *Fruit* obconical, mostly 3-locular, 4–7 mm long, 4–7 mm diam.; disc c. 1 mm wide, slightly raised then sharply depressed.

Distinguished from *E. camphora* by the short adult leaves with very short petioles, the very short petioles on the juvenile leaves, the short, thick peduncles and pedicels, and the stubby fruits.

Included in *E. camphora* by Anderson (1956).

SELECTED SPECIMENS (from 10 examined): NEW SOUTH WALES: Southern Tablelands: Paddys River bridge, c. 2 km N of Penrose, *P. Ollerenshaw 738*, 28.7.1985 (CBG, MEL, NSW); *K. Hill 1338 & L. Johnson*, 14.2.1986 (CANB, MEL, NSW, PERTH).

DISTRIBUTION: Known only from a single stand on a broad swampy river flat near Penrose (Figure 10). This locality has also been cited as 'Wingello' (e.g. on type specimen), which is equally correct.

CONSERVATION STATUS: 2V. This taxon occurs on a poor swampy site which would not be under immediate direct threat from pastoral activity, but fire and long-term habitat modification pose a serious threat.

13. Eucalyptus retinens *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. cypellocarpa* characteribus sequentibus differt: cortex persistens subfibrosus ad modum 'box'; alabastra minora brevioraque; folia adulta minora.

TYPE: NEW SOUTH WALES: Northern Tablelands: Dyamberin Station, Connaughtmans Creek area, c. 15 miles [24 km] NW of Ebor, *R.J. Turner 11*, 2.8.1954 (Holo NSW 182117).

Tree to 20 m. *Bark* rough, shortly fibrous-flaky, dark grey, persistent to lower branches, upper branches smooth, pale, greenish-grey or pinkish. *Juvenile leaves* opposite, sessile, becoming petiolate, ovate, cordate, apically tapered, obtuse, green, sub-glossy, to 12 cm long, 5.5 cm wide. *Adult leaves* disjunct, lanceolate, falcate, acuminate, glossy bright green, 10–17 cm long, 1.5–2.5 cm wide; petioles flattened, 1.2–2.6 cm long. *Inflorescence* simple, axillary; umbellasters 7-flowered; peduncles 2-winged, 8–17 mm long, to 5 mm wide at apex; pedicels angled, 0–5 mm long. *Mature buds* elongate, angular, 8–10 mm long, 4–5 mm wide. *Calyptra* double, outer shedding early, inner ½ as long as hypanthium, wider than hypanthium, rounded, ultimately obtuse. *Fruit* cup-shaped, mainly 3-locular, faintly angular, to 10 mm long, 8 mm diam.; calyptra scar distinct, narrow, slightly raised, separated from hypanthium and disc; disc to 1.5 mm wide, flat or slightly raised, ultimately incurved and enclosing valve bases; valves broadly triangular, vertically raised and ultimately exserted (Figure 11).

E. retinens is distinguished from *E. cypellocarpa* L. Johnson by the persistent, 'box'-type bark, the shorter adult leaves (often more than 17 cm long in *E. cypellocarpa*), the

smaller buds (10–12 mm long in *E. cypellocarpa*) and the 'woodland tree' habit with a short bole and spreading canopy. The similar *E. volcanica* L. Johnson & K. Hill is distinguished by the glaucous, orbicular juvenile leaves, resembling more those of *E. goniocalyx* F. Muell. ex Miq.

This taxon had previously been considered part of *E. elaeophora* F. Muell. as applied by Blakely (1934) to the taxon now known to be *E. goniocalyx*. With the correct application of *E. goniocalyx* and the recognition of *E. cypellocarpa* (Johnson 1962), *E. retinens* was noted as a possibly distinct taxon, and is formalized here.

E. alaticaulis Watson & Ladiges recently described from Victoria is a similar parallel development within the *E. cypellocarpa* group, differing in the generally 'finer' buds and fruit with more slender pedicels and peduncles. The original circumscription of *E. alaticaulis* included another as yet unnamed taxon in this group occurring in coastal Victoria, from Anglesea west almost to Cape Otway. This latter taxon is coarser in all respects, but notably distinguished by the very large orbicular green juvenile leaves.

SELECTED SPECIMENS (from 12 examined): NEW SOUTH WALES: Northern Tablelands: Guy Fawkes

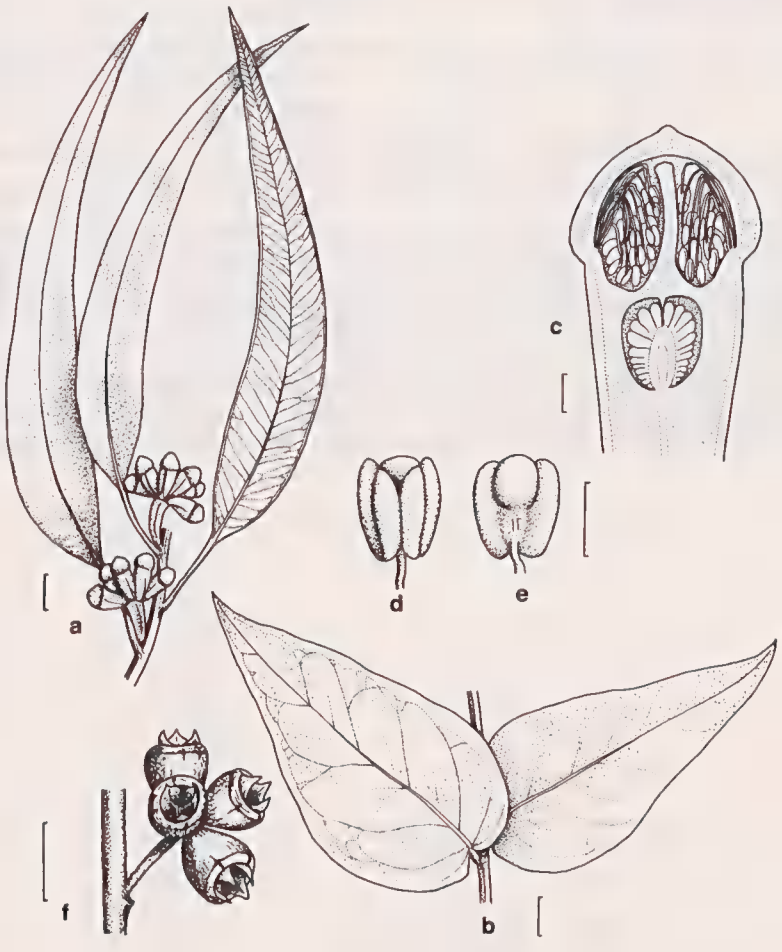

Figure 11. *E. retinens*. **a.**, shoot with buds. **b.**, juvenile leaves. **c.**, median section of bud. **d. e.**, anthers. **f.**, fruit (all from *R.J. Turner 11*). Scale bar: a,b,f = 1 cm; b = 5 mm; c,d = 1 mm.

National Park, rim of Granite Gorge, *D. Charley 14*, 1984 (NSW); Wollomombi Gorge, *E.N. McKie*, 10.1.1930 (NSW); Wollomombi Falls, *M.I.H. Brooker 6069*, 23.1.1979 (CANB, NSW); 1 mile [1.6 km] NW of Hillgrove, *L.A.S. Johnson NSW 182115*, 25.2.1958 (NSW); side of Tia River, below falls, *W. Forsyth*, 10.1900 (NSW); Kangaroo Flat road, 7 miles [11.2 km] NE of Yarrowitch, *J.C. Cousins*, 21.2.1956 (NSW).

DISTRIBUTION: NEW SOUTH WALES: Eastern parts of the Northern Tablelands, in scattered stands at the heads of gorges of the Macleay and southern Clarence River systems (Figure 12).

ECOLOGY: Distinctly localized in occurrence, on shallow soils over Palaeozoic sediments or rarely granites, at immediate edges of steep gorges or upper parts of steep ridges, in association with *E. melliodora* A. Cunn. ex Schauer, *E. viminalis* Labill. and *E. laevopinea* R. Baker.

The epithet is from the Latin *retinens*, 'retaining', referring to the persistent bark.

CONSERVATION STATUS: Not considered to be at risk.

14. Eucalyptus volcanica *L. Johnson & K. Hill*, **sp. nov.**

Inter species *E. cypellocarpae* affines combinatione characterum sequentium distinguitur: cortex trunci persistens, folia juvenilia orbicularia glaucaque, calyptra acuta conica basi constricta, fructus pedicellatus valvis fere inclusis.

TYPE: NEW SOUTH WALES: Northern Tablelands: 5 km E. of Mt Lindesay on Barraba fire trail, *K. Hill 2111*, 27.8.1986 (holo NSW; iso BRI, CANB, CBG, PERTH).

Tree to 25 m tall. *Bark* variably persistent, ranging from lower trunk to full trunk and large to middle branches, grey, fibrous-flaky; shedding above. *Juvenile leaves* opposite, orbicular to ovate, sessile, rounded, sometimes acute, glaucous or pruinose on both sides, crenulate, to 5.5 cm long, 4.5 cm wide. *Adult leaves* disjunct, lanceolate, falcate, glossy bright green, 10–18 cm long, 1.3–3.0 cm wide, petioles 1.5–3.3 cm long. *Inflorescence* simple, axillary; umbellasters 7-flowered; peduncles 8–14 mm long, flattened apically; pedicels 2–6 mm long. *Buds* ovoid, constricted at suture between calyptra and hypanthium, to c. 7 mm long, 4 mm diam. *Calyptra* double, outer shed

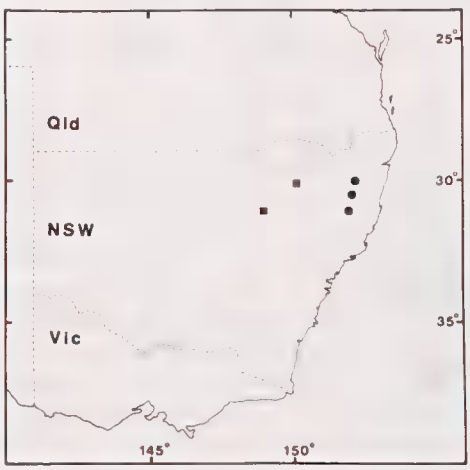

Figure 12. Distribution of *E. retinens* (circle) and *E. volcanica* (square).

early, inner conical, inflated, ± rostrate, about half as long as hypanthium. *Fruit* cup-shaped, usually 3-locular, 8–10 mm long, 7–9 mm diam.; calyptra scar flat; disc initially flat, then sharply descending; valves level with rim to slightly exserted.

Distinguished by the combination of persistent bark on the trunk, orbicular glaucous juvenile leaves, acute conical calyptra with a basal constriction, and pedicellate fruit with substantially enclosed valves.

SELECTED SPECIMENS (from 10 examined): NEW SOUTH WALES: Northern Tablelands: Rangers Look-out, Plains of Heaven track, *L.A.S. Johnson 7842*, 1.9.1974 (NSW); 1 km W of Coryah Gap archway on Mt Kaputar–Narrabri road, *K.L. Wilson 2472 & J.T. Waterhouse*, 19.8.1979 (NSW); Mt Kaputar, *M.I.H. Brooker 4758*, 15.4.1975 (CANB, NSW); foot of Mt Lindesay, *R.H. Cambage 2413*, 5.11.1909 (NSW); Mt Kaputar plateau, *B.G. Briggs 4304*, 5.6.1971 (NSW). North Western Slopes: Siding Springs observatory hill, *M.I.H. Brooker 5205*, 1.7.1976 (CANB, NSW); top of Mt Bulaway, *W. Forsyth*, 10.1899 (NSW).

DISTRIBUTION: Sporadic stands in higher parts of the Nandewar and Warrumbungle Ranges (Figure 12).

ECOLOGY: Locally frequent, on a range of sites on relatively shallow soils on elevated country on mainly trachytic volcanics.

The epithet is from the Latin *volcanicus*, referring to the trachyte and similar volcanic substrates on which it grows.

CONSERVATION STATUS: Not considered to be at risk.

15. **Eucalyptus nobilis** *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. viminali* characteribus sequentibus differt: cortice ex toto laevi; umbellastrae 7-florae; folia juvenilia majora latiora nitidiora; folia adulta majora.

TYPE: NEW SOUTH WALES: Northern Tablelands: 17 km NW of Nowendoc on the main divide, *L. Johnson 9021*, 23.4.1984 (holo NSW; iso CANB, BRI).

Tree to 70 m; bole long, straight. *Bark* smooth, white, pale grey or pale grey-green, excorticating in long ribbons. *Juvenile leaves* opposite, sessile, glossy green, eventually becoming petiolate, lanceolate to broad-lanceolate, acute, to 15 cm long, 5 cm wide.

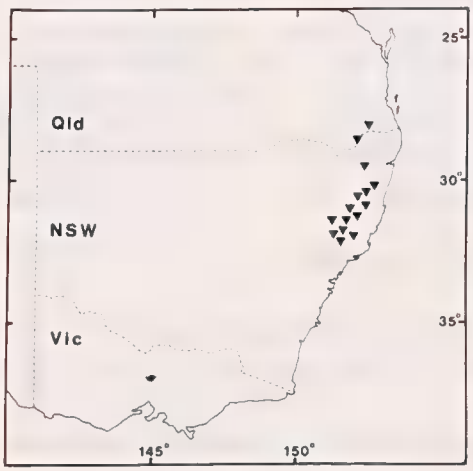

Figure 13. Distribution of *E. nobilis*.

Adult leaves disjunct, lanceolate, acuminate, often falcate, 8–20 cm long, 1.0–3.0 cm wide; petioles 1–3 cm long. *Inflorescence* simple, axillary; umbellasters 7-flowered; peduncles 2-angled, 5–12 mm long; pedicels 0–3 mm long. *Mature buds* ovoid, 7–9 mm long, c. 4 mm diam. *Calyptra* double; outer shedding early; inner as long as hypanthium, convex, usually acute or rostrate, sometimes obtuse. *Fruit* cup-shaped, 3- rarely 4-locular, 4–6 mm long, 5–7 mm diam.; calyptra scar distinct, narrow, continuous with hypanthium; disc 1–2 mm wide, domed; valves vertically exserted, ultimately incurved, broadly triangular, obtuse.

E. nobilis is distinguished from *E. viminalis* Labill. by the consistently tall, straight habit with a long bole, the smooth bark virtually throughout, the 7-flowered umbellasters and the larger juvenile leaves (usually less than 12 cm long in *E. viminalis*). The juvenile leaves are also relatively broader and glossier than those of *E. viminalis* (which has linear to narrow-lanceolate juvenile leaves).

E. nobilis had been recognised as distinct from typical *E. viminalis* and included in *E. huberiana* Naudin by Blakely (1934), his concept of which also included *E. viminalis* Labill. subsp. *cygnetensis* Boomsma (now separated), as well as an introgessive hybrid series between *E. viminalis* and *E. nova-anglica* Deane & Maiden which develops 7-flowered umbellasters. No type is known for *E. huberiana*, and the description suggests that it may be a hybrid of *E. viminalis*.

Intergrades between *E. viminalis* and *E. nobilis* occur in the north-eastern parts of the Northern Tablelands. Hybrids between *E. nobilis* and *E. nitens* (Deane & Maiden) Maiden are also known but are not abundant.

SELECTED SPECIMENS (from 51 examined): QUEENSLAND: E of Tannymorel on the main range, *S.T. Blake 19225*, 16.9.1955 (NSW, BRI); Cunninghams Gap, *L. Johnson NSW 222311*, 3.6.1961 (NSW). NEW SOUTH WALES: Northern Tablelands: Mt Bajimba, *A. Floyd 839*, 19.1.1978 (NSW). 0.9 km from Ebor–Grafton road on North Dorrigo road, *K. Hill 2734, L. Johnson & P. Weston*, 18.10.1987 (NSW); Styx River State Forest, *F.M. Bailey*, 3.1.1935 (NSW); 3 km along Fenwick Road from Oxley Highway, *P. Hind 4697*, 7.12.1986 (NSW); Doyles River State Forest, near Wauchope, *M. Clayton 19*, 29.4.1987 (NSW, CBG); Cairds Gap, Liverpool Range, *L.A.S. Johnson & E.F. Constable NSW 32038*, 31.10.1954 (NSW); Tomalla Tableland, *H.L. White* 3, 7.1918 (NSW).

DISTRIBUTION: Ranges of the south-eastern Darling Downs of Queensland, extending south along the ranges of eastern Northern Tablelands of New South Wales, and west along the Liverpool Range (Figure 13).

ECOLOGY: This species occurs in tall forests on deep, fertile soils at high altitudes in high rainfall areas, often in association with *E. obliqua* L'Hérit. and sometimes *E. fastigata* Deane & Maiden, usually in the vicinity of *E. pauciflora* Sieber ex Sprengel woodland. At slightly lower altitudes, *E. nobilis* adjoins and sometimes occurs within tall forests of *E. saligna* Sm. with associated species such as *E. microcorys* F. Muell.

The epithet is from the Latin *nobilis*, 'noble' or 'excellent', referring to the tall, straight habit.

CONSERVATION STATUS: Not considered to be at risk.

16. Eucalyptus elliptica *(Blakely & McKie) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *Eucalyptus mannifera* Mudie var. *elliptica* Blakely & McKie in Blakely, Key Eucalypts: 148 (1934).

TYPE CITATION: '. . . depicted on Plate 111 from Mt Lindsay Station, Nandewar Mtns, 3200 feet, the type'.

TYPE: NEW SOUTH WALES: Mt Lindsay Station, Nandewar Mtns, 3200 ft [970 m], *R.H. Cambage 2348*, 4.11.1909 (Holo NSW).

≡ *E. mannifera* Mudie subsp. *elliptica* (Blakely & McKie) L. Johnson, Contrib. New South Wales Natl Herb. 3: 108 (1962).

Juvenile leaves opposite, ovate to orbicular. Intermediate leaves disjunct, broad-lanceolate to ovate, falcate. Adult leaves disjunct, broad-lanceolate. Buds rounded, with long pedicels (2–4 mm).

Detailed studies by the authors and others (Chappill 1988) suggest that the members of the 'mannifera group' are not as closely related to each other as previously thought (although not necessarily a paraphyletic group). *E. elliptica* and *E. praecox* Maiden are consequently regarded as distinct species. The former thus requires a new combination at specific rank. The appropriate nomenclatural combination for the latter already exists.

SELECTED SPECIMENS (from 28 examined): NEW SOUTH WALES: Northern Tablelands: Mt Kaputar, *M.I.H. Brooker 4757*, 15.4.1975 (CANB, NSW); 0.7 km N of Oakey River hydro track on Armidale–Kempsey road, *K. Hill 1303 & L. Johnson*, 12.9.1985 (NSW); c. 9 miles [14 km] E of Armidale, *M.I.H. Brooker 3919*, 29.2.1973 (CANB, NSW); 3 miles [4.8 km] N of Bendemeer on New England Highway, *J.B. Williams 710*, 5.1959 (NSW); 4.5 km SSE of Bendemeer on New England Highway, *G.M. Chippendale 1244 & M.J. Brennan*, 11.4.1975 (CANB, NSW); 16 miles [26 km] from Walcha on Yarrowitch road, *F.M. Bailey 8*, 3.1.1935 (NSW); Hanging Rock, *J.B. Williams NE043515A*, 6.11.1983 (NSW, NE); *J.H. Maiden & J.L. Boorman*, 6.1906 (NSW); NW slopes of Tomalla Tableland, *L. Johnson*, 30.11.1954 (NSW); 34 miles [54 km] E of Murrurundi, *R. Story 7516*, 13.10.1960 (CANB, NSW).

DISTRIBUTION: Scattered and locally frequent through the Northern Tablelands, from east of Armidale south to east of Murrurundi, with an outlying population near Mt Kaputar (Figure 14).

CONSERVATION STATUS: Not considered to be at risk.

17. **Eucalyptus triplex** *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. cinerea* characteribus sequentibus differt: fructus parvi, sessiles, campanulati; folia adulta disjuncta, parva, lanceolata.

TYPE: AUSTRALIAN CAPITAL TERRITORY: SE Brindabella Range, on unnamed peak

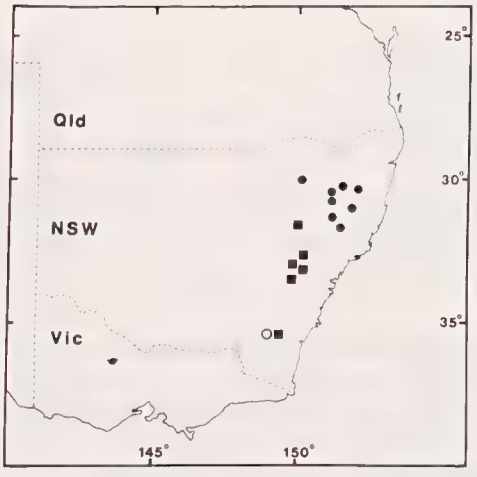

Figure 14. Distribution of *E. elliptica* (solid circle), *E. praecox* (square) and *E. triplex* (open circle).

(35°32'S 148°58'E), *K. Hill 1344 & L. Johnson*, 15.2.1986 (holo NSW, iso CANB).

Tree or mallee to 6 m tall. *Bark* fibrous, dark brown, branches smooth from c. 7 cm diam. *Juvenile leaves* opposite for many nodes, sessile, orbicular, often broader than long, emarginate, crenulate, strongly glaucous, to 4 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate to elliptical, acute, strongly glaucous, 5–10 cm long, 1.5–3.2 cm wide; petioles 5–14 mm long; lateral veins regular, widely spaced, at 30–50° to midrib; intramarginal vein distinct, ± looped, 1–3 mm from margin. *Inflorescences* simple, axillary; umbellasters 3-flowered; peduncles terete, 3–8 mm long. *Buds* sessile, glaucous, ovoid to turbinate, 6–7 mm long, 3–4 mm diam. *Calyptra* double; outer calyptra shedding early; inner calyptra c. ½ as long as hypanthium, hemispherical to shortly conical, obtuse. *Filaments* irregularly flexed, all fertile; anthers oblong, dehiscing by short, broad, parallel slits. *Fruit* sessile, glaucous, campanulate, 3–4-locular, 5–7 mm long, 5–7 mm diam.; calyptra and stemonophore scars raised at c. 45°, c. 0.5 mm wide; disc flat, curving down towards centre, c. 1 mm wide; valves broadly triangular, enclosed. *Seeds* ovoid, dull charcoal grey, shallowly reticulate, hilum ventral; chaff red-brown.

Distinguished from *E. cinerea* F. Muell. by the small, sessile, campanulate fruits (to 8 mm long, 9 mm diam. in *E. cinerea*) and the small, disjunct, lanceolate adult leaves (to 12 cm long, but usually not produced at all in *E. cinerea*).

SELECTED SPECIMENS (from 9 examined): AUSTRALIAN CAPITAL TERRITORY: West face of unnamed mountain, Namadji Natl Park, *R. Gilmour 2216, D.J. Boland & C.M. Black*, 8.2.1985 (CANB, NSW); 3 km NW of Booroomba Rocks, *I.R. Telford 10135 & P. Beesley*, 11.12.1985 (NSW, CBG).

DISTRIBUTION: known from a single site in the ranges to the east of the Bimberi Range in the southern A.C.T. (Figure 14).

ECOLOGY: Locally frequent in cracks in a broad microgranite outcrop, with numerous scleromorphic shrub species. *E. dalrympleana* Maiden subsp. *dalrympleana* and *E. pauciflora* Sieber ex Sprengel occur on adjacent deeper soils.

The epithet is from the Latin *triplex*, 'triple', in reference to the 3-flowered umbellasters.

CONSERVATION STATUS: 2VCt. The entire population is in a remote area in Namadji National Park, and secure from all but catastrophic fire.

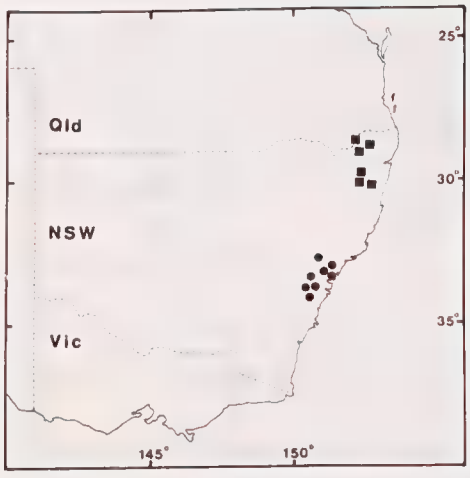

Figure 15. Distribution of *E. benthamii* (circle) and *E. dorrigoensis* (square).

18. Eucalyptus dorrigoensis *(Blakely) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *Eucalyptus benthamii* Maiden & Cambage var. *dorrigoensis* Blakely, Key Eucalypts: 162 (1934).

TYPE CITATION: 'N.S.W. — Wild Cattle Creek and Megan, Dorrigo District, at an elevation of 2–3000 feet. (D.C. Kennedy, 3/1920 and W.A.W. de Beuzeville specimens constitute the type.)'

TYPE: NEW SOUTH WALES: Wild Cattle Creek, Dorrigo, *W.A.W. de Beuzeville NSW 118429*, 9.1931 (lecto: NSW, here designated). This sheet was mounted and labelled 'Type' by Blakely, and the front cover annotated with his Key number, a procedure he followed with specimens that he selected as the single Type for the species.

Juvenile leaves elliptical. Umbellasters 7–11-flowered. Buds obtuse, not glaucous.

E. dorrigoensis has in the past been included in *E. benthamii* Maiden & Cambage, which it superficially resembles. The two differ markedly in structure of the outer calyptra, however, that of *E. dorrigoensis* shedding normally well before anthesis with a well-defined abscission layer. The abscission layer appears to be suppressed in *E. benthamii*, with outer calyptra growth stopping in young buds, and the still expanding inner calyptra bursting through the top as the buds develop. This leaves several irregular scarious remnants attached, which usually dry and fall before anthesis (as observed by Brooker & Kleinig 1983).

SELECTED SPECIMENS (from 31 examined): NEW SOUTH WALES: Northern Tablelands: Boonoo Boonoo Falls, *L.G. Rutley*, 12.7.1956 (NSW); 20 miles [32 km] W of Drake, *C.E. Harbison*, 26.1.1954 (NSW); Black Snake Creek, Bruxner Highway, *K. Hill 812 & L. Johnson*, 9.5.1984 (NSW); N boundary of London Bridge State Forest (29°50'S 152°10'E), *R.H. Squire*, 17.11.1969 (NSW); Paddys Land State Forest, *R.J. Turner*, 13.5.1955 (NSW); Megan, *K. Hill 2729, L. Johnson & P. Weston*, 18.10.1987 (NSW); Moonpar turnoff, NW of Dorrigo, *M.I.H. Brooker 6078*, 23.1.1979 (CANB, NSW).

DISTRIBUTION: Scattered and locally abundant through the north-eastern Northern Tablelands of New South Wales. This species is dominant in country north-west of Dorrigo, but by no means restricted to that area (Figure 15).

ECOLOGY: Usually on relatively fertile but well-drained soils of a variety of types and origins.

CONSERVATION STATUS: Not considered to be at risk.

19. Eucalyptus coolabah *Blakely & Jacobs* in Blakely, Key Eucalypts: 245 (1934).

TYPE CITATION: Blakely cites several figures from Maiden (*Crit. Revis. Eucalyptus* 2: pl. 52), and a number of localities in N.S.W., Qld, S.A., N.T. and W.A.

TYPE: NEW SOUTH WALES: Bogan R., near Coolabah, *J.H. Maiden & J.L. Boorman NSW 33887*, 26.3.1904 (lecto NSW, here designated). Illustrated by Maiden (*Crit. Revis. Eucalyptus* 2: pl. 52, fig. 18c). This specimen best illustrates the diagnostic features of the species, and was cited by Blake (1953) as the type, although he did not formally designate it as lectotype.

The 'coolibahs' are a complex group forming a geographic replacement mosaic over much of inland Australia. Some 10 or 11 entities may be distinguished, and will be treated in detail in a forthcoming account of the group. Blakely (1934) recognised part of the complexity, with his recognition of 3 species and 3 varieties. Blake (1953), however, took a broader view, reducing these to two species only. We now regard *E. coolabah* as a distinct species, and accept one of Blakely's varieties, var. *arida*, as a subspecies (the other, var. *rhodoclada*, we would regard as a distinct species, and will discuss elsewhere). We also distinguish a third subspecies in *E. coolabah*, as below.

E. coolabah is the south-eastern and eastern 'coolibah' of Qld, N.S.W., S.A. and N.T., extending through much of the drier country south, east and north-east of Alice Springs. It is the only member of the group in S.A., N.S.W. and the major part of Qld, extending north to the divide between the inland and Gulf river systems.

Bark persistent on trunk and lower branches, 'box'; middle and outer branches smooth, white. Calyptra hemispherical to conical. Fruit hemispherical; disc narrow, depressed; valves stongly exserted, spreading; pedicel 2–4 mm long, slender.

Three geographically separated subspecies may be distinguished on the basis of adult leaf morphology. There are extensive zones of intergradation where the ranges of the subspecies adjoin (Figure 16).

Key to subspecies

1 Buds, fruit and twigs glaucous .....19A. subsp. **coolabah**
1* Buds, fruit and twigs not glaucous
  2 Calyptra conical, acute .....19B. subsp. **excerata**
  2* Calyptra rounded, obtuse .....9C. subsp. **arida**

19A. Eucalyptus coolabah *Blakely & Jacobs* subsp. coolabah

Adult leaves chartaceous, glaucous. *Calyptra* double, outer shed early, inner conical, acute or obtuse, about as long as hypanthium. *Twigs*, buds and fruit glaucous.

This subspecies occupies the centre of the range of the species, from around Menindee east to the Macquarie Marshes, north through the grey clay soil plains country of the Warrego, Bulloo and Barcoo river systems to Winton. Usually on flat sites on heavy, grey, cracking clay soils.

Intergradation is extensive with both subsp. *excerata* and subsp. *arida*. Intergrading populations are frequently highly variable, showing a full range of variation between the two taxa within single stands. Hybrids are also known with *E. largiflorens* F. Muell., *E. intertexta* R. Baker and *E. ochrophloia* F. Muell.

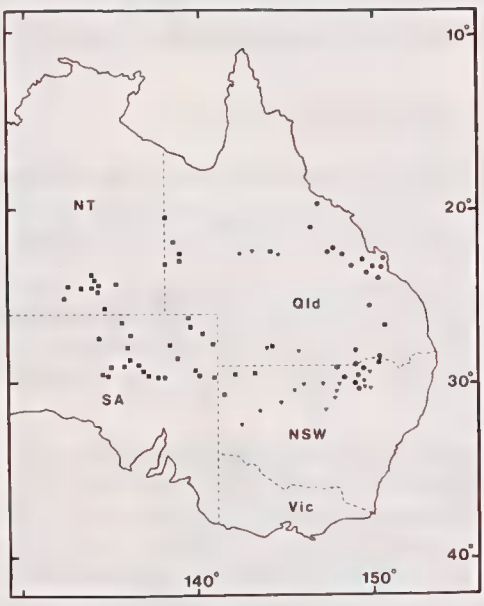

Figure 16. Distribution of *E. coolabah* subsp. *coolabah* (triangle), subsp. *excerata* (circle) and subsp. *arida* (square).

SELECTED SPECIMENS (from 33 examined): QUEENSLAND: Creek near Winton, *S.W. Jackson 6A*, 8.1918 (NSW); Diamantina River, *F.M. Bailey*, 6.1892 (NSW); Muttaburra, *C.T. White*, 4.1919 (NSW, BRI); Mackenzie River, N of Duaringa, *A.N. Rodd 4405*, 15.4.1985 (NSW, BRI); Gilruth Plains, Cunnamulla, *R. Roe G19*, 2.1941 (CANB, NSW). NEW SOUTH WALES: North Western Plains: Bourke, *J.L. Boorman NSW 10049*, 6.1901 (NSW); Bourke district, *O.C. McDougal NSW 10048*, 1897 (NSW); Darling River near 'East Toorale', *K. Wells & J. Curtis 60*, 25.3.1973 (CANB, NSW); 130.7 km E of Barwon River Bridge at Collarenebri, *B. Wiecek 125*, 22.8.1987 (NSW, BRI, CANB); Namoi River, Narrabri, *G. Burrow*, 1.1930 (NSW); Wee Waa, *R.T. Baker*, 7.1911 (NSW); Boolcarrol, *J. Hay*, 12.1911 (NSW); Macquarie Marshes 80 miles [128 km] N of Warren, *E.F. Constable NSW 20392*, 2.5.1952 (NSW); Sandy Camp station, 10 miles [16 km] W of Quambone, *G.M. Chippendale & E.F. Constable NSW 19216*, 22.5.1951 (NSW). Far North Western Plains: 'Nangara', Acres Billabong, 17 km E of Tilpa, *D. Ferguson*, 22.12.1974 (NSW); 10 km E of Darling River bridge at Wilcannia, *K. Hill 825 & L. Johnson*, 6.7.1984 (AD, CANB, NSW, PERTH). Far South Western Plains: Kinchega National Park, *G. Ryan & J. Everly [McBarron No. 16750]*, 2–5.6.1969 (NSW). SOUTH AUSTRALIA: Coopers Creek, Lake Perigundi (27°47'S 139°34'E), *B.C. Crisp 550*, 3.6.1979 (NSW, AD, CBG).

CONSERVATION STATUS: Not considered to be at risk.

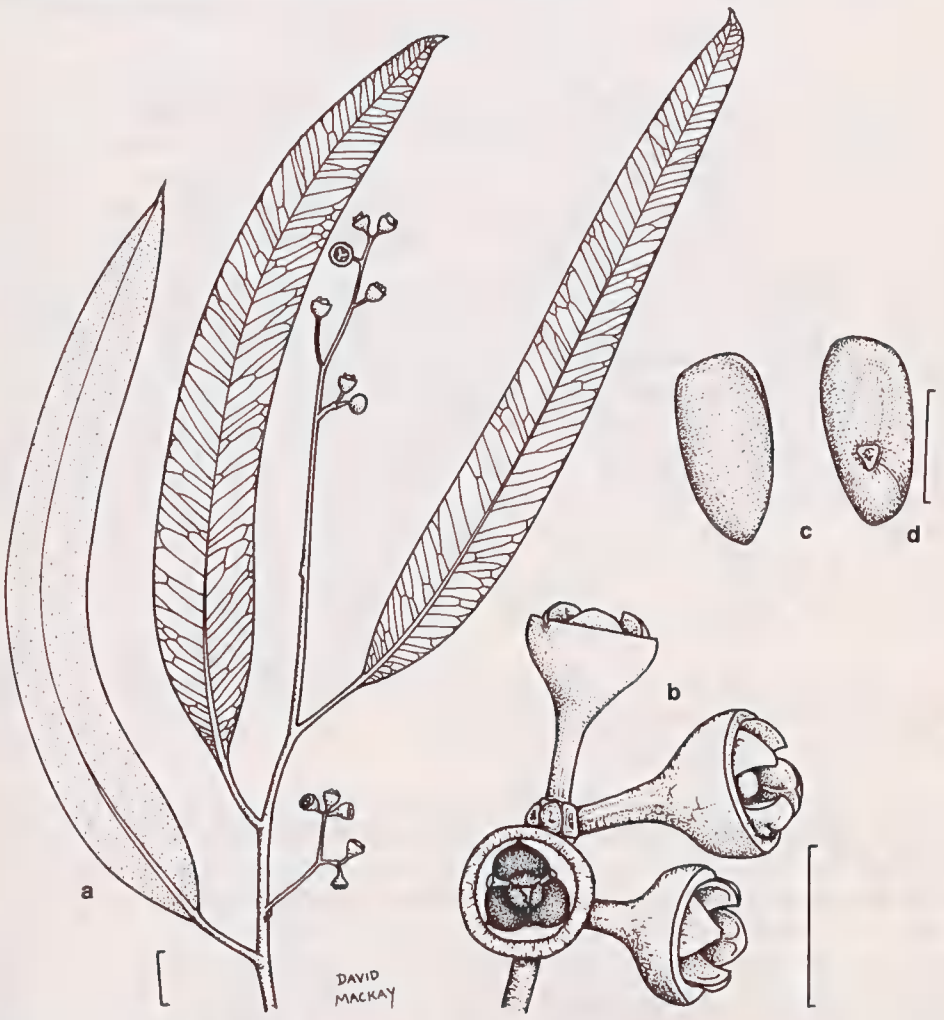

Figure 17. *E. coolabah* subsp. *excerata*. **a.**, shoot with fruiting inflorescences. **b.**, fruit. **c.**, **d.**, seeds (all from *K. Hill 1185 & L. Johnson*). Scale bar: a = 1 cm; b = 5 mm; c,d = 1 mm.

19B. Eucalyptus coolabah *Blakely* subsp. **excerata** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie *coolabah* ramulis, foliis, alabastris et fructibus non glaucis; ab subspecie *arida* foliis adultis tenuibus et calyptra acuta; distinguitur.

TYPE: QUEENSLAND: Blowhard Creek, Charters Towers to Clermont road, *K. Hill 1185 & L. Johnson*, 21.8.1984 (holo NSW; iso BRI, CANB, MEL).

Adult leaves chartaceous, green, non-glaucous. *Buds* and fruit non-glaucous. *Calyptra* double, outer shed early, inner acute, slightly longer than hypanthium (Figure 17).

Distinguished from subsp. *coolabah* by the non-glaucous leaves, buds and fruit, and from subsp. *arida* by the thin-textured adult leaves and the acute calyptra.

Restricted to the east of the range of the species, from the upper Darling River system (Moree to Goondiwindi) north through the western Darling Downs into the Fitzroy River system north of Rockhampton, and on to east of Einasleigh (Figure 16). Restricted to eastern drainage systems for the most part in the north of the range, although extending into some western headwaters. In the latter areas, this subspecies occurs along creeks in rolling country with narrower, somewhat sandier floodplains, and subspecies *coolabah* occurs on the flat, heavy soil plains.

Intergradation is extensive with subspecies *coolabah* where the ranges overlap, and extensive populations in these areas display a full range of variation between the two taxa. Hybrids are also known with *E. crebra* F. Muell., *E. melanophloia* F. Muell. (hybrids have been named *E. bucknellii* Cambage, *E. rivularis* Blakely and *E. yagobiei* Maiden), *E. populnea* F. Muell. (hybrids have been named *E. populnea* F. Muell. var. *obconica* (Blakely) Cameron), *E. largiflorens* F. Muell., *E. pilligaensis* Maiden and *E. albens* Benth.

SELECTED SPECIMENS (from 38 examined): QUEENSLAND: Reid River, 30 miles [48 km] S of Townsville, *N. Daley 5*, 24.2.1912 (NSW); 1 km S of Cape River crossing on Charters Towers–Clermont road, *A.N. Rodd 4556 & M. Hardie*, 25.4.1985 (BRI, CANB, NSW); 47 km NNW of Clermont on Charters Towers road, *A.N. Rodd 4560 & M. Hardie*, 26.4.1985 (BRI, CANB, NSW); Mackenzie River 14 miles [22 km] N of Duaringa, *S.L. Everist 14*, 28.1.1954 (BRI, NSW); West Rockhampton, *W.N. Jaggard 1&2*, 12.1911 (NSW); 4 miles [6.4 km] S of Wowan, *N.H. Speck 2013*, 18.5.1964 (CANB, NSW); 35 miles [56 km] N of Biloela, *C.R. Dunlop*, 25.5.1969 (NSW, CBG); Palm Tree Creek, 20 km N of Taroom, *M.D. Crisp 2880*, 7.6.1977 (BRI, CANB, CBG, NSW); 28.5 km W of turnoff to Chinchilla N of Jandowae, *M.I.H. Brooker 7312*, 6.5.1982 (CANB, NSW); Goondiwindi, *R.B. McIntyre*, 18.1.1912 (NSW). NEW SOUTH WALES: North Western Plains: near McIntyre River, Boggabilla, *L.A.S. Johnson & E.F. Constable NSW 32213*, 9.11.1954 (NSW); New Angledool, *A.B. Paddison*, 2.1900 (NSW); Mookoo, near Mungindi, *R.H. Cambage 4370*, 19.12.1922 (NSW); Gundamaine, near Narrabri, *H. Deane 131*, 4.1885 (NSW); 50 miles [80 km] W of Narrabri, *W.F. Blakely*, 8.1936 (NSW).

The epithet is from the Latin *ex*, 'without, not', and *cerata*, 'waxed', in reference to the absence of evident wax (pruinosity or glaucousness).

CONSERVATION STATUS: Not considered to be at risk.

19C. Eucalyptus coolabah *Blakely & Jacobs* subsp. **arida** *(Blakely) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *Eucalyptus coolabah* Blakely & Jacobs var. *arida* Blakely, Key Eucalypts: 246 (1934).

TYPE CITATION: 'Desert country from Cooper's Creek, S.A., to Doraminna, N.T.' ['Doraminna' is a typographical misinterpretation of Ooraminna.]

TYPE: SOUTH AUSTRALIA: Kopperamana, Cooper Creek, *H. Basedow 17*, 11.1919 (lecto NSW 10046, here designated; iso BRI).

Although not so designated in the protologue, this specimen was selected and annotated as 'Type' by Blakely in NSW.

Adult leaves coriaceous, non-glaucous. *Buds* and fruit non-glaucous. *Calyptra* double, outer shed early, inner hemispherical or broadly conical, as long as or slightly shorter than hypanthium. *The anthers* are also slightly larger than those of the other two subspecies.

This is the western subspecies, widespread in north-eastern South Australia, extending into far north-western N.S.W., south-eastern N.T. and western Queensland. This subspecies is often on sandy or gravelly creek lines through stony or sandy desert country (though on heavier soils than those occupied by the representative of *E. camaldulensis* Dehnh. sens. lat. in these regions); and is abundant through the 'Channel Country' along Coopers Creek.

SELECTED SPECIMENS (from 58 examined): QUEENSLAND: 12 miles [19.2 km] N of 'Wooroona' homestead, *G.M. Chippendale NT4998*, 10.1.1966 (NSW, NT); Carandotta, SE of Urandangie, *S.T. Blake 10195*, 16.11.1935 (BRI, CANB, NSW, NT); 83 km E of Winton–Hughenden road on Muttaburra road, *M.I.H. Brooker 7860*, 7.12.1982 (CANB, NSW); Glenormiston, *A.C. Boyle*, 28.1.1935 (BRI, NSW); 108 km from Quilpie on Thargomindah road, *R. Johnston 461 & J. Turner*, 8.3.1981 (CANB, CBG, NSW). NEW SOUTH WALES: Far North Western Plains: 9.5 km S of 'Delalah House' towards Dribbling Bore, *J. Pickard 2051*, 25.3.1973 (NSW); 3 km S of Tindara, *M.I.H. Brooker 6163*, 24.3.1979 (CANB, NSW); Teilta Lake, *M.I.H. Brooker 6159*, 24.3.1979 (CANB, NSW). SOUTH AUSTRALIA: Dalhousie Springs, 77 miles [123 km] N of Oodnadatta, *D.E. Symon 3273*, 12.2.1965 (ADW, K, NSW); 34 km along track to Moomba, 132 km S of Birdsville, *T. O'Leary*, 10.1985 (NSW); Poonina Waterhole, *J.Z. Weber 9136*, 5.9.1986 (AD, NSW); Cooper Creek at Innamincka, *D.E. Symon 5734*, 18.8.1968 (ADW, CANB, NSW); Neales River on Oodnadatta road, *K. Hill 845, 846 & L. Johnson*, 8.7.1984 (NSW); 25 km SE of William Creek, *M.I.H. Brooker 9294*, 22.5.1986 (CANB, NSW); Paisley Creek, c. 50 km S of William Creek on Marree road, *K. Hill 842 & L. Johnson*, 8.7.1984 (NSW); Margaret River, c. 15 km SE of Coward Springs railway, *K. Chorney 971*, 2.10.1978 (AD, NSW); Strzelecki Track 200 km S of Innamincka, *T. O'Leary*, 10.1985 (NSW); Kennebery Creek, 28 km W of Marree, *K. Hill 839 & L. Johnson*, 8.7.1984 (AD, NSW, PERTH); 20 km from Hawkers Gate, in S.A., *T. O'Leary*, 7.10.1985 (NSW). NORTHERN TERRITORY: Deep Well road, 12 miles [19 km] S of Alice Springs, *D.J. Nelson 1161*, 21.12.1967 (NSW, NT); 3 miles [4.8 km] S of Spinifex Bore, Deep Well station, *P.K. Latz 40*, 31.12.1967 (NSW, NT); 76 miles [122 km] SW of Alice Springs, *C.E. Carter*, 7.5.1951 (NSW); 59.8 km E of Curtin Springs, *K. Hill 857 & L. Johnson*, 10.7.1984 (NSW).

CONSERVATION STATUS: Not considered to be at risk.

20. Eucalyptus ophitica *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. fibrosa* characteribus sequentibus differt: calyptra brevior, latior, rotundata; antherae minores; folia juvenilia angustiora.

TYPE: NEW SOUTH WALES: North Coast: 10.0 km S of Baryulgil on Grafton road (29°18'S, 152°38'E), *K. Hill 797 & L. Johnson*, 7.5.1984 (holo NSW; iso BRI, CANB, K, MEL, PERTH).

Tree to 10 m high. *Bark* persistent to smaller branches, hard, flaky 'ironbark'; smooth, whitish on branches less than c. 7 cm diam. *Juvenile leaves* disjunct, broad-lanceolate, rounded, to 15 cm long, 6 cm wide; petioles to 2.0 cm long. *Adult leaves* disjunct, similifacial, lanceolate to broad-lanceolate, obtuse or acute, 7–15 cm long, 1.3–3.2 cm wide; petioles to 2.8 cm long; lateral veins moderately spaced, regular, at 40–50° to midrib; reticulum even, obscure; oil glands obscure; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. *Inflorescences* compound, terminal or axillary; umbellasters 3–7-flowered, sometimes somewhat irregular; peduncles terete, 2–11 mm long; pedicels 4–7 mm long, tapering into buds and fruit. *Mature buds* clavate, 8–10 mm long, 4–5 mm diam. *Calyptra* double; outer shedding early; inner hemispherical,

broadly apiculate, as long as hypanthium, slightly wider than hypanthium. *Fruit* conical, convex, 4–5-locular, 5–7 mm long, 5–7 mm diam.; calyptra scar less than 0.1 mm wide; stemonophore flat, 0.2–0.4 mm wide; disc raised at 15–30°, ultimately incurved, 1.0–1.5 mm wide; valves broadly triangular, exserted, raised at 40–70°. *Seeds* subglossy, red-brown, rounded, elliptical, almost smooth; hilum ventral; chaff similar (Figure 18).

Distinguished from *E. fibrosa* F. Muell. by the hemispherical calyptra that is broader than the hypanthium (the calyptra is not broader than the hypanthium in *E. fibrosa*), and the broad-lanceolate juvenile leaves (*E. fibrosa* has ovate juvenile leaves). The anthers of *E. ophitica* are also smaller than those of *E. fibrosa*.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Coast: serpentine country, upper Clarence River, *C.I. Davison*, 8.12.1942 (NSW); Baryulgil district, *R.J. Turner*, 7.1955 (NSW); 10.0 km S of Baryulgil on Grafton road, *K. Hill 796, 798 & L. Johnson*, 7.5.1984 (NSW).

DISTRIBUTION: New South Wales: North Coast, Baryulgil district (Figure 19).

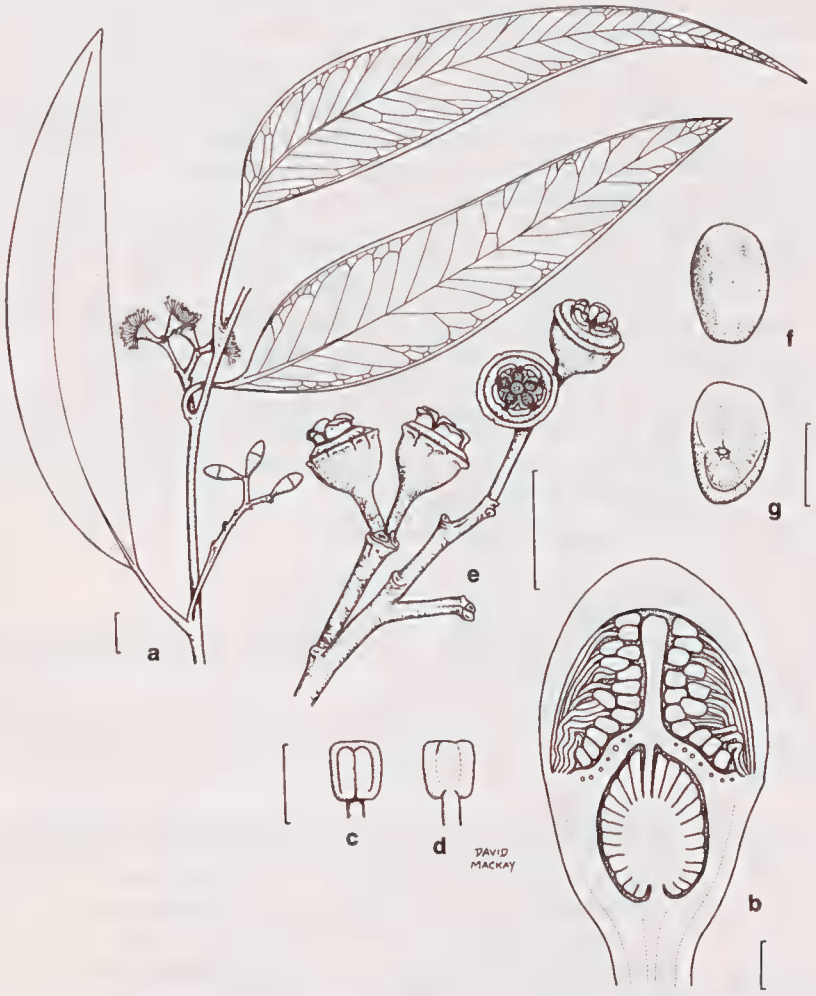

Figure 18. *E. ophitica*. **a.**, shoot with buds and flowers. **b.**, median section of bud. **c.**, **d.**, anthers. E, inflorescence with fruit. **f.**, **g.**, seeds (a, e, f, g from *K. Hill 797 & L. Johnson*, b, c, d from *K. Hill 796 & L. Johnson*). Scale bar: a,e = 1 cm; b,f,g = 1 mm; c,d = 0.5 mm.

ECOLOGY: Locally abundant in grassy woodland on skeletal red loamy soils over undulating to hilly serpentinite outcrops. Known only from outcrops of the Baryulgil serpentinite belt.

The epithet is from the Greek *ophites*, 'serpentine' (rock), referring to the substrate on which the species is found.

CONSERVATION STATUS: 2V-. Not known to occur on reserved lands, and under potential threat from pastoral activity. Further field study of population distribution is required.

21. Eucalyptus populnea *F. Muell.*, J. Linn. Soc., Bot. 3: 93 (1859).

= *E. populifolia* Hook., Mitchell's Trop. Austral.: 204 (1848), non Desf. (1829).

TYPE CITATION: None cited. The plant was collected when Mitchell's expedition was in the vicinity of Mount Owen, Central Queensland.

TYPE: QUEENSLAND: Mt Owen, *T.L. Mitchell 336*, 18.6.1846 (holo CGE, n.v.).

Maiden (*Crit. Revis. Eucalyptus* 3: 93) stated that Mitchell's specimen belonged to *E. alba* Reinw. ex Bl. [sens. lat.; = *E. platyphylla* F. Muell. sens. strict.]. However, Mt Owen is a considerable distance from the nearest occurrence of this species, and well within the range of *E. populnea*. Chippendale (1988) regarded the later illustration of this taxon by Hooker (*Icon. Pl.* t. 879 (1851)) as a distinct publication with a separate type, whereas we would regard this as an amplification of the earlier description using a more comprehensive specimen to compile the illustration.

[*E. micrantha* A. Cunn. ex Maiden, Crit. Revis. Eucalyptus 1: 340 (1908), in syn., nom. nud.; non DC. (1827).]

[*E. polyanthemos* Schauer var. *populifolia* F. Muell. ex Maiden, Crit. Revis. Eucalyptus 1: 340 (1908), in syn., nom. nud.]

Two geographic subspecies may be recognized in this taxon, one in the north of the range of the species and one in the south (Figure 20). Substantial intergradation occurs in the intermediate region.

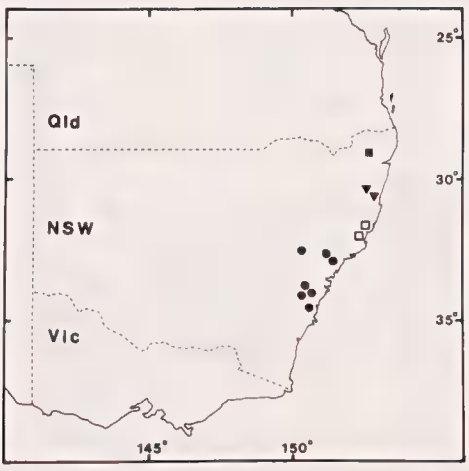

Figure 19. Distribution of *E. ophitica* (solid square), *E. ancophila* (triangle), *E. rudderi* (open square) and *E. hypostomatica* (circle).

Key to subspecies

1 Fully adult leaves rounded .....21A. subsp. **populnea**
1* Fully adult leaves acute .....21B. subsp. **bimbil**

21A. Eucalyptus populnea *F. Muell.* subsp. **populnea**

Tree to 20 m tall. *Bark* persistent to larger branches, fibrous-flaky ('box'), patchy grey and pale grey; smaller branches smooth, grey. *Adult leaves* ovate to orbicular or ± deltoid, very glossy, rounded to emarginate, 4–10 cm long, 4–10 cm wide; petioles 1.8–4 cm long. *Inflorescences* simple, axillary, but often aggregated on leafless shoots; umbellasters 7–11-flowered; peduncles 4–10 mm long; pedicels 0–3 mm long. *Buds* ovoid, 3–4 mm long, 2–2.5 mm diam. *Calyptra* double, outer shed early, inner hemispherical, slightly shorter than hypanthium. *Fruit* cup-shaped to obconic, 3–4 mm long, 3–4 mm diam. *Calyptra* scar flat; disc depressed, valves enclosed.

Adult leaves ovate-orbicular, obtuse, rounded or emarginate. *Petioles* long, relatively slender. Buds and fruit small.

SELECTED SPECIMENS (from 39 examined): QUEENSLAND: Rockhampton, *R. Simmons*, 1903 (NSW); 'Gadwall', Alpha, *G.H. Wood*, 18.10.1911 (NSW); 7 miles [11 km] W of Emerald, *Adams 1286*, 15.9.1964 (CANB, NSW); 2 miles [3.2 km] W of Dawson River, W of Moura, *N.H. Speck 1898*, 20.10.1963 (CANB, NSW); 0.5 miles [0.8 km] S of Gayndah on road to Wigton homestead, *M.I.H. Brooker 3756*, 29.8.1972 (CANB, NSW); Bendemere, *S.L. Everist 4443*, 8.7.1952 (NSW, BRI); 25 miles [40 km] ENE of Dalby on road to Kogan, *S.L. Everist*, 10.1969 (NSW, BRI); Leyburn, *A.E.A. McMahon*, 25.9.1911 (NSW).

This is the northern and eastern taxon, extending from the northern limit on about the Tropic of Capricorn south to the western Darling Downs. Extensive intergradation occurs with subsp. *bimbil* in the south of the range. Both taxa are characteristic of flat sites on fairly heavy red or brown clay-loams, not occurring however on the heaviest grey clay soils. There is also, at its northern limits in Queensland, a south-west to north-east belt of intergrades with the closely related *E. brownii* Maiden & Cambage, which occurs on similar substrates.

CONSERVATION STATUS: Not considered to be at risk.

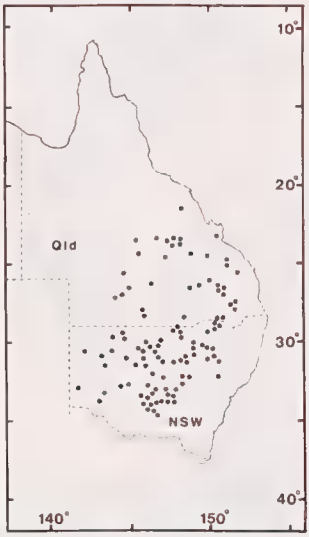

Figure 20. Distribution of *E. populnea* subsp. *populnea* (square), subsp. *bimbil* (solid circle) and intergrading forms (open circle).

21B. Eucalyptus populnea *F. Muell.* subsp. **bimbil** *L. Johnson & K. Hill*, **subsp. nov.**

Folia adulta ovata, acuta. Petioli breviores crassioresque, alabastra fructusque majores quam eis subspeciei *populneae*.

TYPE: NEW SOUTH WALES: South Western Plains: 32 km NW of Rankin Springs towards Hillston, *J.D. Turner 86 & H. Vos*, 12.9.1977 (holo NSW; iso CANB, MEL, AD, PERTH).

Tree to 25 m tall. *Bark* persistent to larger branches, fibrous-flaky ('box'), patchy grey and pale grey; smaller branches smooth, grey. *Adult leaves* broad-lanceolate to ovate, highly glossy, acute or apiculate, 5–12 cm long, 2–5 cm wide, petioles 0.9–3.5 cm long. *Inflorescences* simple, axillary, but often aggregated on leafless shoots; umbellasters 7–11-flowered; *peduncles* 4–10 mm long; pedicels 0–3 mm long. *Buds* ovoid, 3–5 mm long, 2–3 mm diam. *Calyptra* hemispherical, slightly shorter than hypanthium. *Fruit* cup-shaped to obconic, 3–5 mm long, 3–5 mm diam. *Calyptra* scar flat; disc depressed, valves enclosed.

Adult leaves broad-lanceolate to ovate, acute or apiculate. *Petioles* shorter and thicker than those of subsp. *populnea*. *Buds* and fruit generally larger than those of subsp. *populnea*.

Extensive intergrades between the subspecies occur in southern Queensland and adjoining N.S.W. Inland forms of both subspecies tend to be coarser in all parts.

Herbarium specimens in leaf only can be confused with *E. behriana* F. Muell., but are distinguishable by the smooth adult leaf margin in comparison to the finely irregular rough adult leaf margin of *E. behriana*. The latter is a mallee, with much less 'box' bark.

Local intergrading populations occur with *E. largiflorens* F. Muell., in sites intermediate between those occupied by the parent species.

Hybrids are known with *E. coolabah* subsp. *excerata* (hybrids = *E. populnea* F. Muell. var. *obconica* (Blakely) Cameron), *E.* sp. aff. *drepanophylla* F. Muell. ex Benth., *E. crebra* F. Muell. (hybrids = *E. rariflora* Blakely), *E. melanophloia* F. Muell. (hybrids = *E. beasleyi* Blakely), *E. intertexta* R. Baker, *E. microcarpa* (Maiden) Maiden, *E. pilligaensis* Maiden and *E. conica* Deane & Maiden.

SELECTED SPECIMENS (from 85 examined): QUEENSLAND: Barcaldine, *H. Robinson*, 9.10.1911 (NSW); c. 26 km N of Adavale, *D.E. Boyland 8079*, 10.10.1979 (CANB, NSW, AD, MO, PRE, SP, BRI); 59 km S of Quilpie towards Thargomindah, *J. Turner 459 & R. Johnston*, 8.3.1981 (CANB, NSW, CBG); Mitchell Highway, 25 km S of Cunnamulla, *A.N. Rodd 4579 & M. Hardie*, 29.4.1985 (NSW, BRI, CANB). NEW SOUTH WALES: North Western Slopes: 12 km E of Gunnedah on Oxley Highway, *M.I.H. Brooker 6052*, 22.1.1979 (CANB, NSW). Central Western Slopes: 1.2 miles [1.9 km] W of Peak Hill, *R. Eakin 78*, 1.12.1970 (CANB, NSW); 10 km N of Wirrinya West (33°39'S 147°41'E), *K. Wells & J. Curtis 53*, 19.3.1973 (CANB, NSW). South Western Slopes: halfway between Narrandera and Leeton, *K. Wells 8, 32*, 27.4.1972 (CANB, NSW). North Western Plains: near Whalan Creek, c. 8 miles [12 km] SW of Boggabilla, *Walker ANU 302*, 27.5.1962 (CANB, NSW); Lightning Ridge, *E.F. Constable NSW 19251*, 28.5.1951 (NSW); Bourke to Nyngan, *N. Hall H74/14*, 12.6.1974 (CANB, NSW); 1 km E of Byrock, *K. Wells 106*, 15.7.1974 (CANB, NSW); 30.5 km SSE of Coonamble on Gilgandra road, *S.L. Everist S22*, 7.12.1969 (NSW, BRI). South Western Plains: 32 km NW of Rankins Springs towards Hillston, *J.D. Turner 86 & H. Vos*, 12.9.1977 (CANB, NSW). Far North Western Plains: Yantabangee Creek, 65 km direct NE of White Cliffs, *L.A.S. Johnson 8468*, 16.5.1979 (NSW). Far South Western Plains: 'Pan Ban' station, ENE of Pooncarie, *J.C. Noble & R.A. Bawden*, 18.7.1979 (NSW).

DISTRIBUTION: Extending from around Barcaldine in central Queensland to the lower Darling River in south-western N.S.W., on heavy soil flats, although not on the heaviest grey cracking clays (Figure 20).

The subspecific epithet is from the aboriginal (Wiradhuri) name *bimbil*, and recalls the

widely used popular name of this species, 'bimble box', especially in New South Wales where it is represented by this subspecies.

CONSERVATION STATUS: Not considered to be at risk.

22. Eucalyptus hypostomatica *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. rudderi* foliis adultis latioribus hypostomaticisque distinguitur.

TYPE: NEW SOUTH WALES: Central Coast: 0.3 miles [0.5 km] from Lumbys Road on Langans Road, Correbare State Forest (33°00'S 151°15'E), *M.I.H. Brooker 4624*, 11.11.1974 (holo NSW; iso CANB).

Tree to 30 m tall. *Bark* persistent, finely tessellated, dark grey, shortly fibrous-flaky ('box') on trunk and sometimes larger branches; branches smooth, grey. *Juvenile leaves* disjunct; broad-lanceolate to ovate, bright green, petiolate, strongly discolorous, to 10 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate or ovate, acute or acuminate, glossy green, strongly discolorous (hypostomatic), 8–18 cm long, 1.0–3.0 cm wide; petioles flat, 10–18 mm long; lateral veins well-spaced, regular, finely regularly reticulate between, at 30–50° to midrib; intramarginal vein distinct, ± looped, 0.5–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 3–8 mm long; pedicels 1–2 mm long. *Buds* ovoid, 4–5 mm long, 2–3 mm diam. *Calyptra* double; outer shedding early; inner much shorter than hypanthium, broadly conical, obtuse. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* ovoid to obconic, mainly 3-locular, 4–5 mm long, 3–4 mm diam.; stemonophore persistent; disc vertically depressed; valves deeply enclosed.

Distinguished from *E. rudderi* Maiden by the broad-lanceolate to ovate, hypostomatic adult leaves.

SELECTED SPECIMENS (from 23 examined): NEW SOUTH WALES: North Coast: Pokolbin State Forest (32°52'S 151°09'E), *M.I.H. Brooker 4628*, 12.11.1974 (CANB, NSW). Central Coast: Mt Warrawalong, Wattagan State Forest (33°02'S 151°21'E), *L. Johnson NSW 135699*, 23.11.1959 (NSW); 11 miles [17.6 km] E of Laguna, *E.F. Constable NSW 56649*, 25.5.1960 (NSW); Lacys Creek, Lower Burragorang Valley, *J. Kellow 202*, 18.5.1960 (NSW); Nattai River, downstream from Wanganderry Creek (34°18'S 150°21'E), *I. Olsen 2170*, 29.6.1974 (NSW); Kangaroo Valley, *M.N. Fackender NSW 135704*, 1965 (NSW).

DISTRIBUTION: Scattered, in isolated populations from the Pokolbin district of N.S.W. south to Kangaroo Valley, and inland as far as Widdin Brook in the upper Hunter Valley (Figure 19).

ECOLOGY: A component of grassy or sclerophyll forests on steep sites in subcoastal ranges.

The epithet is from the Greek *hypo-*, 'beneath', and *stoma*, 'a mouth', in reference to the hypostomatic adult leaves.

CONSERVATION STATUS: 3R-. Although fairly widespread, this species occurs in small and isolated stands. Many occurrences are in State Forest areas, and relatively secure in the short term.

23. Eucalyptus magnificata *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. baueriana* foliis, alabastris, fructibus majoribus crassioribusque distinguitur.

TYPE: NEW SOUTH WALES: Northern Tablelands: Enmore, 18 miles [29 km] E of Uralla, *R.H. Cambage 3776*, 18.3.1917 (holo NSW)

Tree to 8 m tall. *Bark* persistent, grey, shortly fibrous-flaky ('box') on trunk and sometimes larger branches; branches smooth, grey. *Juvenile leaves* disjunct, orbicular, grey-green, petiolate, concolorous, to 8 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate or ovate, acute, dull glaucous or grey, concolorous, 5–10 cm long, 4–6 cm wide; petioles slender, 15–30 mm long; lateral veins well-spaced, regular, at 30°–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, ± looped, 1–3 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles terete, 7–13 mm long; pedicels thick, terete, 2–4 mm long. *Buds* glaucous, ovoid, 6–7 mm long, 3–4 mm diam. *Calyptra* double, outer shedding early. Inner shorter and narrower than hypanthium, conical, obtuse. *Stamens* regularly inflexed, outer whorls longer and infertile. *Anthers* adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* glaucous, obconic, sometimes split around rim, 3–4-locular, 7–10 mm long, 6–9 mm diam. *Stemonophore* persistent; disc vertically depressed. *Valves* deeply enclosed.

Distinguished from *E. baueriana* Schauer by the larger, coriaceous adult leaves (to 8 cm long, 5 cm wide in *E. baueriana*), and the larger, coarser buds (to 6 mm long, 3 mm diam. in *E. baueriana*) and fruit (to 7 mm long, 6 mm diam. in *E. baueriana*).

SELECTED SPECIMENS (from 8 examined): QUEENSLAND: Cottonvale Road, 1.3 km S of Dalveen, *P. Holzworth 4a*, 13.9.1983 (NSW); 13 miles [21 km] from Stanthorpe, *A. Murphy*, 3.1904 (NSW). NEW SOUTH WALES: Northern Tablelands: Ferryman area, 25 miles [40 km] E of Hillgrove, *J. Battarbee NSW 30906*, 12.1954 (NSW, K, BRI); Hillgrove, outskirts of town, *R.W. Jessup & M. Gray 1420*, 5.1952 (NSW).

DISTRIBUTION: Known from scattered populations east and south-east of Armidale, and near Stanthorpe (Figure 21).

ECOLOGY: Locally frequent in open grassy woodland on relatively infertile sandy podsols.

The epithet is from the Latin *magnificatus*, 'magnified', in reference to the larger leaves, buds and fruits than those of related taxa.

CONSERVATION STATUS: 3V-. Although the total range is not small, this species occurs in

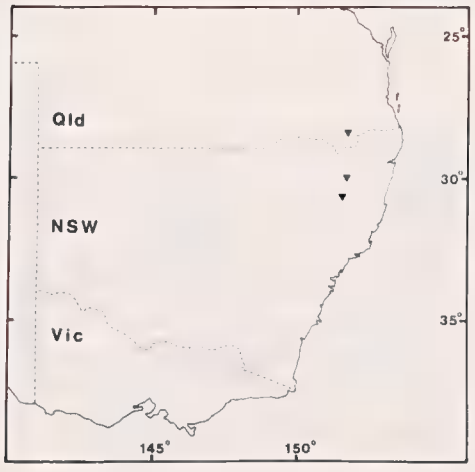

Figure 21. Distribution of *E. magnificata*.

scattered populations, most of which are in productive grazing country and under considerable long-term threat.

24. Eucalyptus polyanthemos *Schauer,* in Walp., Rep. Bot. Syst. 2, Suppl. 1: 924 (1843).

TYPE CITATION: 'Bathurst. — A. Cunn. Herb. no. 136/1822!'

TYPE: holo W (n.v.); iso BM(n.v.), K.

Two subspecies are recognised on the basis of regional differences in bark type. Both occur over a wide range, with a limited zone of intergradation where the ranges adjoin (Figure 22).

Key to subspecies

1 Bark patchily adherent or smooth on the trunk, shedding in large scales .....24A. subsp. **polyanthemos**

1* Bark persistent to middle branches, 'box' .....24B. subsp. **vestita**

24A. Eucalyptus polyanthemos *Schauer* subsp. **polyanthemos**

= *Eucalyptus ovalifolia* R. Baker, Proc. Linn. Soc. New South Wales 25: 680 (1901).

TYPE CITATION: '*Hab.* — Bathurst, Rylstone and Camboon (R.T. Baker); Hargraves (A.A. Sutton); Gerogery (L.Mann).'

TYPE: NEW SOUTH WALES: Cow Flat, Bathurst, *R.T. Baker,* 10.2.1901 (lecto NSW).

Lectotype designated by Maiden (*Crit. Revis. Eucalyptus 2: 132*). Baker had annotated a specimen with the locality of 'Bylong' as Type, but as this locality was not cited in the protologue it can have no significance. Included in *E. polyanthemos* by Maiden (*Crit. Revis. Eucalyptus* 2: 109, 111).

= *E. ovalifolia* R. Baker var. *lanceolata* R. Baker & H.G. Smith, Res. Eucalypts: 124 (1902).

TYPE CITATION: '*Habitat.* — Camboon, Rylstone (R.T.B.), Hargraves (A.A. Sutton), Wellington, New South Wales.'

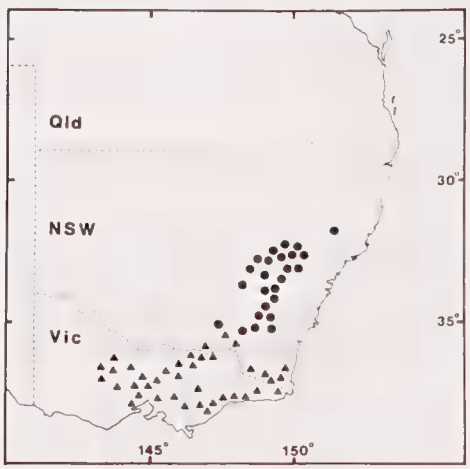

Figure 22. Distribution of *E. polyanthemos* subsp. *polyanthemos* (circle) and subsp. *vestita* (triangle).

TYPE: NEW SOUTH WALES: Camboon, N of Rylstone, *R.T. Baker NSW 19153*, 10.10.1893 (lecto NSW, here designated). This specimen is one of several from this locality endorsed with the varietal name by Baker, whereas none from the other cited localities are so endorsed. The specimen bears leaves, buds and flowers. Included in *E. polyanthemos* by Maiden (*Crit. Revis. Eucalyptus* 2: 111).

Bark mostly smooth, sometimes irregularly persistent on trunk. *Adult leaves* broad-lanceolate or ovate, similifacial.

The two subspecies show a zone of intergradation around Tumut. Sporadic hybrids are found with *E. conica* Deane & Maiden in the Gulgong–Ulan district (Central Western Slopes).

SELECTED SPECIMENS (from 134 examined): NEW SOUTH WALES: Central Tablelands: Mullions Range, 14 miles [22 km] NNE of Orange, *R. Coveny 4164*, 15.4.1972 (NSW); Capertee, *J.L. Boorman 7*, 11.1900 (NSW); Abercrombie Caves, *E.F. Constable NSW 39826*, 21.3.1955 (NSW). Southern Tablelands: 3 miles [5 km] NW of Gundaroo, *L.G. Adams 1910*, 28.6.1967 (CANB, NSW, BRI, K, L); Bungendore road, near Captains Flat turnoff, *L. Burgess CBG 030870*, 24.8.1969 (CBG, NSW); Black Mountain Reserve, A.C.T., *R. Coveny 11513 & P. Hind*, 18.1.1983 (CANB, K, NSW). Central Western Slopes: Sempill Creek, on Tomalla road, *L. Johnson NSW 30070*, 30.11.1954 (NSW); Stuart Town, *J.L. Boorman 1*, 6.1900 (NSW); Grenfell district, *A.H. Lawrence*, 9.1915 (NSW). South Western Slopes: Burrinjuck, *R.H. Cambage 1912*, 25.1.1908 (NSW); Wolongawah, Tumut, *W.A.W. de Beuzeville*, 6.9.1916 (NSW).

DISTRIBUTION: Western parts of the Central and Southern Tablelands, and higher eastern parts on the Central and South Western Slopes, with an outlying population in the upper Hunter River valley (Figure 22).

ECOLOGY: Open woodland on poor, shallow soils on rocky, sloping sites.

CONSERVATION STATUS: Not considered to be at risk.

24B. Eucalyptus polyanthemos *Schauer* subsp. **vestita** *L. Johnson & K. Hill*, **subsp. nov.**

Cortex asper in trunco et saepe in ramis persistens.

TYPE: VICTORIA: Kinglake Road near St Andrews, *P. Carolan*, 14.3.1965 (Holo NSW).

Bark persistent on trunk and larger branches, compact shortly fibrous-flaky with whitish patches ('box' bark).

Limited intergradation occurs with *E. baueriana* in the south of the range, in central Gippsland and west of Melbourne.

SELECTED SPECIMENS (from 72 examined): NEW SOUTH WALES: South Coast: Allan Brook Road, Yambulla State Forest, *A. Nunnink & R. Shiels 371*, 3.2.1981 (NSW). Southern Tablelands: near Ingebyra, N of Snowy–Jacobs River junction, *G.L. Vidler*, 22.5.1958 (NSW); Merriangah station, near Bombala, *D.J. Boland 2067 & L. Thompson*, 22.8.1984 (CANB, NSW). South Western Slopes: 17.8 km SW of Tarcutta towards Holbrook, *G.M. Chippendale 1402 & M.J. Brennan*, 25.7.1975 (CANB, NSW); Jindera, near Albury, *A. Briesl per E.J. McBarron 15399*, 12.6.1968 (NSW). VICTORIA: Reeve Road, W of Orbost (37°35'S 148°16'E), *M.I.H. Brooker 6813*, 16.1.1980 (CANB, NSW); Wattle Circle Road (37°27'S 147°50'E), *A.C. Beauglehole 37102*, 27.2.1971 (NSW); 34 km W of Bairnsdale on road to Sale, *M.I.H. Brooker 6841*, 17.1.1980 (CANB, NSW); Dawson Road (38°01'S 146°12'E), *M.I.H. Brooker 6984*, 30.9.1981 (CANB, NSW); 3.0 km S of Stockyard Creek, Hume Highway E of Chiltern, *K. Hill 1733A, B, L. Johnson & K. Wilson*, 11.3.1986 (NSW); Glenrowan turnoff, Myrtleford to Wangaratta road, *M.I.H. Brooker 4367*, 12.2.1974 (CANB, NSW); 18 miles [29 km] NNE of Bendigo, *E.F. Constable 5252*, 23.10.1964 (NSW); 3.7 km E of St Arnaud towards Avoca, *K. Hill 1627, L. Johnson & K. Wilson*, 6.3.1986 (NSW); 22 miles [35 km] from Benalla towards Mansfield, *M.E. Phillips 17*, 19.10.1971 (NSW, CBG); 11 km from Heathcote towards Tooboora, *M.I.H. Brooker 5977, 5978*, 24.8.1978 (CANB, NSW, MEL); Long

Forest road, Melton district, *M.I.H. Brooker 6994*, 1.10.1981 (CANB, NSW).

DISTRIBUTION: Mainly on undulating country in central Victoria, extending a short distance into New South Wales near Albury, with an outlying population near Bombala. It also extends through drier valleys in Gippsland onto somewhat drier ridge country in East Gippsland and the far South Coast of N.S.W. (Figure 22).

ECOLOGY: A woodland tree on poor, shallow soils, on slopes or, in Victoria, sometimes almost level country.

The epithet is from the Latin *vestitus*, 'clothed', referring to the persistent bark.

CONSERVATION STATUS: Not considered to be at risk.

25. Eucalyptus paniculata *Sm.*, Trans. Linn. Soc. 3: 287 (1797).

TYPE CITATION: 'My specimens were gathered at Port Jackson by Mr. David Burton, and I received them from Sir Joseph Banks's herbarium.'

TYPE: NEW SOUTH WALES: Port Jackson, *D. Burton* (holo LINN; iso BM).

Tree to 50 m tall. *Bark* persistent, corky and heavily kino-impregnated ('ironbark'). *Juvenile leaves* ovate, glossy dark green, disjunct, petiolate, discolorous, to 8 cm long, 4 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate, acuminate, glossy dark green, strongly discolorous, 9–15 cm long, 1.2–3.2 cm wide; petioles slender, 10–20 mm long; lateral veins well-spaced, regular, at 40–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, ± looped, 1–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 7–18 mm long; pedicels quadrangular, 4–11 mm long. *Buds* shortly fusiform, usually slightly 3- or 4-angled, 6–9 mm long, 4–5 mm diam. *Calyptra* double; outer shedding early; inner shorter and narrower than hypanthium with a distinct constriction at the junction, conical, acute. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* obconical to ovoid, 4–5-locular, 6–8 mm long, 6–9 mm diam.; stemonophore persistent; disc vertically depressed; valves deeply enclosed. *Seeds* ovoid, mid-brown, shallowly reticulate, hilum ventral; chaff mid-brown.

Two subspecies may be recognised in *E. paniculata*. Much of the material from the North Coast of New South Wales previously included in *E. paniculata* is separated as several new taxa (see below). *E. fergusonii* R. Baker is also recognised as a distinct species. Study of this group continues, and additional new taxa will be recognised in southern Queensland.

Key to subspecies

1 Adult leaves hypostomatic .....25A. subsp. **paniculata**
1* Adult leaves amphistomatic .....25B. subsp. **matutina**

25A. Eucalyptus paniculata *Sm.* subsp. **paniculata**

= *Eucalyptus nanglei* R. Baker, J. & Proc. Roy. Soc. New South Wales 51: 48 (1917).

TYPE CITATION: 'Localities at present known to me are Morriset, Stroud, Bulladelah [sic], Woy Woy, Lindfield, Nowra.'

TYPE: 'Lindfield and Nowra', *R.T. Baker & L.G. Irby NSW 222254* (lecto NSW, here designated). The only specimens that can be related to Baker's protologue are three small pieces in a single folder, labelled '*E. nanglei* / Lindfield & Nowra / R.T.B. & L.G. Irby'. This sheet has a later annotation of 'Rec. 27.5.20' by J.H. Maiden. The piece with the attached label and bearing leaves, buds and flowers is here designated as

Lectotype, although the collection site cannot be further clarified.

Small to very tall forest tree (to 50 m tall). *Juvenile leaves* ovate. *Adult leaves* fully hypostomatic except for a narrow band of scattered stomata along the midrib of the adaxial surface.

Hybrids occur with *E. moluccana* Roxb., *E. fergusonii* R. Baker, *E. siderophloia* Benth. and *E. bosistoana* F. Muell.

SELECTED SPECIMENS (from 122 examined): NEW SOUTH WALES: North Coast: 5 km N of Bulahdelah on Pacific Highway, *M.I.H. Brooker 7802*, 1.12.1982 (CANB, MEL, NSW, PERTH); Kotara, SW of Newcastle, *R.W. Earp*, 14.4.1954 (NSW). Central Coast: between Avoca Beach and Copacabana, *D.J. McGillivray 1214*, 3.7.1965 (NSW); Hornsby, near Berowra bridge, *W.F. Blakely*, 6.1915 (NSW); 1.5 km from Sir Bertram Stephens Drive on road to Garie Beach, *M.D. Crisp 7791 & P. Weston*, 21.4.1986 (AD, CBG, MEL, NSW). South Coast: 10 miles [16 km] S of Nowra, *R.D. Johnston & H. Vos FRI 13466*, 1.11.1965 (CANB, NSW); Boyne State Forest, 4 miles [6.4 km] N of Batemans Bay, *L. Walker NSW 154351*, 11.1917 (NSW); 6.7 km N of Tilba Tilba, *M.I.H. Brooker 6644*, 12.11.1979 (CANB, NSW). Central Tablelands: 3 miles [5 km] N of Penrose, *W.F. Blakely & G. Butt*, 30.1.1938 (NSW). Central Western Slopes: Glenbawn Catchment, upper Hunter River, *per A.R. Tewksbury*, 3.1950 (NSW).

DISTRIBUTION: The subcoastal range country of N.S.W. from north of the Manning River south to near Bega, extending into the eastern tablelands country in parts. One record exists from the eastern edge of the upper Hunter Valley, Central Western Slopes (Figure 23).

ECOLOGY: A tree of wet to somewhat dry sclerophyll forests, usually on deeper, often somewhat clayey soils in more favourable sites.

CONSERVATION STATUS: Not considered to be at risk.

25B. Eucalyptus paniculata *Sm.* subsp. **matutina** *L. Johnson & K. Hill*, **subsp. nov.**

A subspecie *paniculata* foliis adultis per tota pagina adaxiali stomata sparsiuscule ferentibus distinguitur.

TYPE: NEW SOUTH WALES: North Coast: Tomaree Headland, towards top of ridge to east of hospital, *K. Hill 759 & L. Johnson*, 3.5.1984 (holo NSW; iso BRI, CANB, MEL).

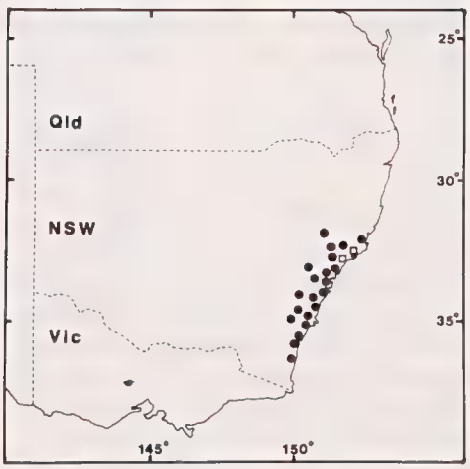

Figure 23. Distribution of *E. paniculata* subsp. *paniculata* (circle) and subsp. *matutina* (open square).

Small tree (to 15 m tall), sometimes dwarfed to a mallee form. *Adult leaves* weakly amphistomatic, i.e. with a regular scattering of stomata over the adaxial surface, but at much lower densities than those on the abaxial surface.

Distinguished by the amphistomatic adult leaves.

SELECTED SPECIMENS (from 23 examined): NEW SOUTH WALES: North Coast: Yacaabah, Port Stephens, *D.F. Blaxell 2081*, 16.5.1984 (NSW); Stephens Peak, Port Stephens, *J. Benson*, 2.1981 (NSW); Box Beach, Nelson Bay, *L.A.S. Johnson 9004–9012*, 20.4.1984 (NSW); 3 km S of Glebe Road, S of Newcastle, *M.I.H. Brooker 7798*, 1.12.1982 (CANB, NSW).

DISTRIBUTION: Known from a few populations in the Port Stephens district and south of Newcastle (Figure 23).

ECOLOGY: Locally abundant on coastal headlands, near-coastal hills and beach dunes in the area immediately north and south of Port Stephens, with a single record from south of Newcastle. In other regions populations near the sea appear to belong to the hypostomatic subsp. *paniculata*.

The epithet is from the Latin *matutinus*, 'of the morning', in allusion to the easterly distribution.

CONSERVATION STATUS: 2V-. Further study is required to delimit the populations of this taxon.

26. Eucalyptus fergusonii *R. Baker*, J. & Proc. Roy. Soc. New South Wales 51: 415 (1917).

TYPE CITATION: 'Geographical Range. — Bulladelah [sic] and Wingello.'

TYPE: NEW SOUTH WALES: Bulladelah [= Bulahdelah], *L.C. Maxwell*, 10.1916 (lecto NSW 222250, here designated).

This specimen represents the form with long pedicels, 4-angled fruit and amphistomatic leaves that Baker had in mind when drawing up his description. Other specimens relating to the citation represent typical *E. paniculata* and intergrades with it.

[*E. terminalis* Sieb. ex Benth., Fl. Austral. 3: 212 (1867), in syn., nom. nud., nec F. Muell. (1859), nec Britten (1901).]

Tree to 30 m tall. *Bark* persistent, corky and heavily kino-impregnated ('ironbark'). *Juvenile leaves* ovate, glossy dark green, disjunct, petiolate, strongly discolorous, to 13 cm long, 6 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate, acuminate, glossy dark green, strongly discolorous, 8–16 cm long, 1.5–3.2 cm wide; petioles slender, 9–22 mm long; lateral veins well-spaced, regular, at 30–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, ± looped, 1–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 6–18 mm long; pedicels 6–17 mm long. *Buds* fusiform, distinctly 4-angled, 8–13 mm long, 5–6 mm diam. *Calyptra* double; outer shedding early; inner shorter and narrower than hypanthium with a distinct constriction at the junction, conical, acute. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* quadrangular, ovoid to obconical, 4–5-locular, 7–13 mm long, 5–10 mm diam.; stemonophore persistent; disc vertically depressed; valves deeply enclosed. *Seeds* ovoid, dark brown, shallowly reticulate, hilum ventral; chaff brown.

E. fergusonii has previously been regarded as a form of *E. paniculata* (Pryor & Johnson 1971). The prime distinguishing character is the strongly 4-angled fruits of *E. fergusonii*, although substantial interbreeding appears to occur in areas where the two are sympatric (see below).

Two subspecies may be recognised in *E. fergusonii* on the basis of regional differences in stomatal distribution in adult leaves.

Key to subspecies

1 Adult leaves amphistomatic; fruit obconical .....26A. subsp. **fergusonii**
1* Adult leaves hypostomatic; fruit ovoid .....26B. subsp. **dorsiventralis**

26A. Eucalyptus fergusonii *R. Baker* subsp. **fergusonii**

Adult leaves amphistomatic (but distinctly discolorous). *Buds* 8–10 mm long. *Fruit* obconical, 7–11 mm long.

An uncommon taxon, all known occurrences of which are associated with, or not far from, stands of *E. paniculata* subsp. *paniculata*. Extensive interbreeding occurs, and the *E. fergusonii* is apparently disappearing through assimilation of genetic material from *E. paniculata*. In areas where the two are sympatric, *E. fergusonii* is readily distinguished by the amphistomatic leaves combined with the fruit character. However, *E. paniculata* may have amphistomatic leaves in the area east of the range of *E. fergusonii* (*E. paniculata* subsp. *matutina*), and *E. fergusonii* has hypostomatic leaves in areas to the west of the range of *E. paniculata* (*E. fergusonii* subsp. *dorsiventralis*).

SELECTED SPECIMENS (from 11 examined): NEW SOUTH WALES: North Coast: Pacific Highway, 3 km N of Karuah, *J.T. Waterhouse 9503 & K.L. Wilson*, 24.8.1979 (NSW); 7.2 km from Seahampton on Sugarloaf road, *K. Hill 752 & L. Johnson*, 3.5.1984 (BRI, CANB, NSW); Wattagan Road, at N gate into State Forest from Quorrobolong, *K. Hill 748 & L. Johnson*, 2.5.1984 (NSW). Central Coast: Morisset, *R.T. Baker* (NSW).

DISTRIBUTION: Very sporadic, represented by collections from Bulahdelah to Morisset (Figure 24).

ECOLOGY: A component of dry to rather wet sclerophyll forests. It is difficult to perceive any clear difference in habitat from that of *E. paniculata*.

CONSERVATION STATUS: 3R-. Further study is required to delimit the populations of this taxon. This subspecies appears to be hybridising extensively with *E. paniculata* subsp. *paniculata*, and may be at risk of becoming genetically 'submerged' within the latter taxon.

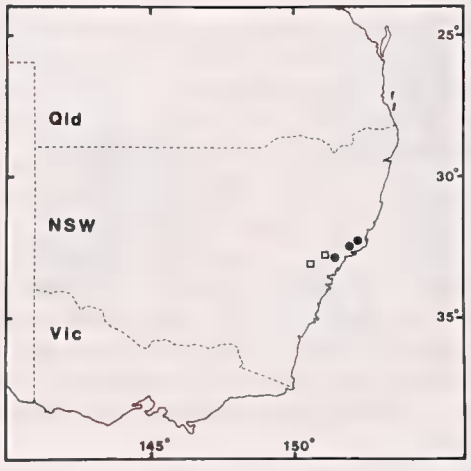

Figure 24. Distribution of *E. fergusonii* subsp. *fergusonii* (circle) and subsp. *dorsiventralis* (open square).

26B. Eucalyptus fergusonii *R. Baker* subsp. **dorsiventralis** *L. Johnson & K. Hill*, **subsp. nov.**

A subspecie *fergusonii* foliis adultis sine stomatibus dispersis in pagina adaxiali distinguitur.

TYPE: NEW SOUTH WALES: North Coast: Old Convict Road, 5.5 km due W of Paynes Crossing bridge, *K. Hill 2783 & L. Stanberg*, 3.5.1988 (holo NSW; iso PERTH, CANB, BRI, MEL, AD).

Distinguished by the hypostomatic adult leaves, the longer buds (10–13 mm long), and the longer, ovoid fruit (10–13 mm long).

SELECTED SPECIMENS (from 5 examined): NEW SOUTH WALES: North Coast: Paynes Crossing, *J. Simpson*, 7.1987 (NSW); Wollombi, *R. Story 6624*, 1.9.1959 (NSW). Central Coast: above Junction of Wollemi Creek and Colo River, *I.S. Olsen 17*, 2.10. 1966 (NSW).

DISTRIBUTION: Known from the Wollombi Valley foothills, N.S.W., apparently extending south-west into the Wollemi Wilderness (Figure 24).

ECOLOGY: A component of dry sclerophyll forests on sandstone ridges.

While known only from a few stands, this taxon occurs in uniform stands with no apparent hybridism or intergradation with other species, in contrast to subsp. *fergusonii*. The ranges of the two subspecies do not overlap, and no intergradation appears to occur.

The epithet is from the Latin *dorsum*, 'back', and *ventralis*, 'pertaining to the belly', referring to the distinctly different surfaces of the hypostomatic adult leaves.

CONSERVATION STATUS: 2RC-. Most known populations of this subspecies occur within reserved lands.

27. Eucalyptus placita *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. paniculata* characteribus sequentibus differt: folia juvenilia adultaque nitide viridia, adulta amphistomatica; cortex mollis, suberosus; fructus breviusculus.

TYPE: NEW SOUTH WALES: North Coast: Manning Hill, on road from Upper Myall to Bunyah (32°15'S 152°11'E), *L. Johnson 9014 & C. Johnson*, 21.4.1984 (holo NSW).

Tree to 25 m tall. *Bark* persistent, soft corky grey ironbark, pale brown under; smaller branches sometimes smooth, grey. *Juvenile leaves* disjunct, ovate to broadly elliptical, bright green, glossy, petiolate, strongly discolorous, to 10 cm long, 7 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate, acute or acuminate, glossy light green, distinctly discolorous (but amphistomatic), 7–15 cm long, 1.4–3.0 cm wide; petioles 12–20 mm long. *Lateral veins* well-spaced, regular, finely regularly reticulate between, at 30–50° to midrib. *Intramarginal vein* distinct, ± looped, 1–3 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 5–11 long; pedicels 4–8 mm long. *Buds* broadly fusiform, 8–11 mm long, 4–5 mm diam. *Calyptra* double; outer shedding early; inner shorter and narrower than hypanthium with a distinct constriction at the junction, conical, acute. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* obconic, 6–9 mm long, 5–7 mm diam., 4–5-locular; stemonophore persistent; disc vertically depressed; valves deeply enclosed (Figure 25).

Distinguished from *E. paniculata* by the glossy light green amphistomatic adult leaves, the glossy light green juvenile leaves, the soft, corky bark, and the relatively short fruit.

This taxon is one of a number in the *E. paniculata* group that form a geographic

replacement pattern along the coast of New South Wales. The taxa are for the most part allopatric, and intergradation is limited. *E. fusiformis* Boland & Kleinig and *E. ancophila* L. Johnson & K. Hill are broadly sympatric or parapatric with *E. placita* at the northern end of the range of the latter, although no intergradation is known.

SELECTED SPECIMENS (from 19 examined): NEW SOUTH WALES: North Coast: 4.8 km from Dungay Road on Boonanghi Road, Boonanghi State Forest, *K. Hill 776 & L. Johnson*, 6.5.1984 (CANB, NSW); Cobrabald Road, 4 km from 5-ways Hill, Bellangry State Forest, *K. Hill 772 & L. Johnson*, 5.5.1984 (NSW); Bril Bril State Forest, NW of Wauchope, *J.C. Cousins*, 5.1957 (NSW); Gloucester Buckets, *R. Coveny*, 8.9.1967 (NSW); Cranky Corner, 13 miles [22 km] SE of Singleton, *R. Story 7389*, 10.5.1960 (NSW); 100 metres on Mt Bright road from Bellbird-Millfield road, *K. Hill 750 & L. Johnson*, 2.5.1984 (NSW).

DISTRIBUTION: North Coast of N.S.W., from the hinterland of the Kempsey district south to around Cessnock (Figure 26).

ECOLOGY: Locally frequent in sclerophyll forests on shallow soils on dry siliceous ridges of acid volcanics or sediments.

The epithet is from the Latin *placitus*, 'pleasing', from the appearance of the rather light green, glossy foliage.

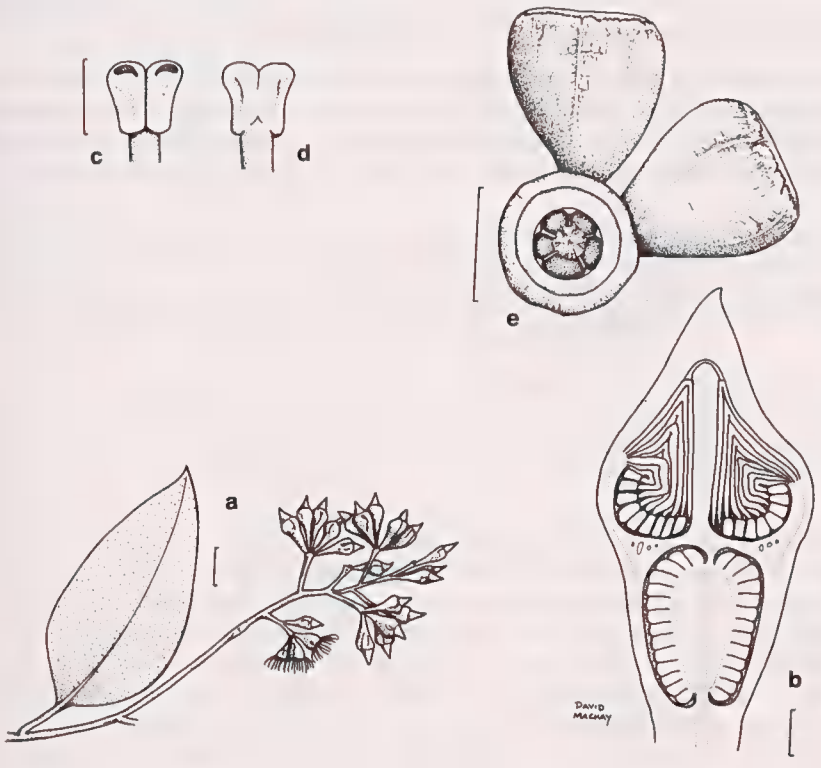

Figure 25. *E. placita*. **a.**, adult leaf and flowers. **b.**, median section of flower. **c.**, **d.**, anthers. **e.**, fruit (from *J.C. Cousins, 5.1957*). Scale bar: a = 1 cm; b = 1 mm; c,d = 0.5 mm; e = 5 mm.

CONSERVATION STATUS: Not considered to be at risk.

28. Eucalyptus ancophila *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. placita* foliis adultis majoribus plus saturate viridibus et angustioribus, ab *E. fusiforme* foliis adultis majoribus et fructibus brevioribus latioribusque, distinguitur.

TYPE: NEW SOUTH WALES: North Coast: 21 miles [33 km] NW of Kempsey, at western ridge of Mungay Creek, *T.J. Evans NSW 222245*, 2.1975 (holo NSW).

Tree to 35 m tall, sometimes taller. *Bark* persistent, dark grey ironbark, smaller branches sometimes smooth, grey. *Juvenile leaves* disjunct, petiolate, lanceolate to narrow-ovate, glossy, distinctly discolorous, to 8 cm long, 4 cm wide. *Adult leaves* disjunct, ± lanceolate, acute or acuminate, ± glossy green, slightly discolorous or concolorous, amphistomatic, 9–20 cm long, 1.8–4.5 cm wide; petioles 18–30 mm long; lateral veins well-spaced, regular, at 30–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, 1–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 5–18 mm long; pedicels 4–6 mm long. *Mature buds* not seen. *Calyptra* double; outer shedding early; inner shorter and narrower than hypanthium with a distinct constriction at the junction, conical, acute. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* broadly obconic or ovoid, 6–8 mm long, 5–7 mm diam.; 4-locular (rarely 3); stemonophore persistent; disc vertically depressed; valves deeply enclosed.

Distinguished from *E. placita* by the lanceolate, darker green and longer adult leaves with longer petioles, and the lanceolate to narrow-ovate juvenile leaves. Distinguished from *E. fusiformis* by the larger and more shining green adult leaves (to 15 cm long in *E. fusiformis*) and the shorter and broader fruit (5–9 mm long, 4–5 mm diam. in *E. fusiformis*).

SELECTED SPECIMENS (from 7 examined): NEW SOUTH WALES: North Coast: Bellingen Heights, *E.H.F. Swain*, 3.1910 (NSW); 3.6 km from W end of Allgomera Creek Road, Ingalba State Forest, *K. Hill 785 & L. Johnson*, 6.5.1984 (NSW); 'Anzac Valley', upper Mungay Creek, *L. Johnson 8710* 28.1.1983 (NSW); Dennis Creek, 6 km direct NNE of Willawarrin, *L. Johnson 8708*, 28.1.1983 (NSW).

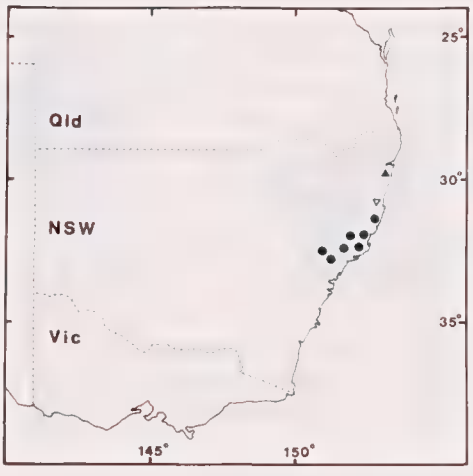

Figure 26. Distribution of *E. tetrapleura* (solid triangle), *E. fusiformis* (open triangle) and *E. placita* (circle).

DISTRIBUTION: Known only from the Kempsey–Bellingen district of coastal N.S.W. (Figure 19).

ECOLOGY: Usually along creeks or valley bottoms in moderately dissected coastal range country, in tall forest with a dense rainforest understorey. This habitat differs from those of both *E. placita* and *E. fusiformis*, which are species of drier forests along ridges.

The epithet is from the Latinised Greek *ancos*, 'a valley', *philus*, 'loving', from the habitat.

CONSERVATION STATUS: 2R. Significant populations of this species occur within State Forests, although overall distribution is still poorly known.

29. Eucalyptus beyeriana *L. Johnson & K. Hill*, **sp. nov.**

Inter species *E. paniculatae* affines foliis adultis juvenilibusque angustis non lucentibus et fructibus parvis distinguitur.

TYPE: NEW SOUTH WALES: Central Coast: Nortons Basin, about 2.5 km NW of Wallacia, *T. James 898, W. Bishop & C. Dunn*, 2.9.1987 (holo NSW; iso CANB).

This name is provided for the taxon previously known as *E. beyeri* R. Baker, which was based on *E. paniculata* Sm. var. *angustifolia* Benth. The type citation for the latter is 'N.S.Wales, "Narrow-leaved Iron-bark", Woolls'. An isotype in NSW from the Woolls herbarium bears the locality 'Moolah', which cannot now be identified. This specimen has anthers intermediate in morphology between those of *E. beyeriana* and *E. crebra* F. Muell. These taxa are often sympatric or closely parapatric, and hybrid individuals occur frequently, although no evidence exists for complex hybrids beyond the F1 generation. Since the type is thus apparently from a plant of hybrid origin, the name *E. beyeri* can no longer be applied in its widely-used sense, and a new name is required. The name *E. beyeriana* is chosen because it is sufficiently similar to the old name to minimise the effect of the change.

= *E. panda* S.T. Blake subsp. *illaquens* L. Johnson, Contrib. New South Wales Natl Herb. 3(3): 120 (1962).

TYPE CITATION: 'HOLOTYPE: 2 miles [3.2 km] E of Munghorn (Cooyal to Wollar), N.S.W., *C.K. Ingram* 22.11.1952 (NSW 54103), flowering and fruiting.'

This name was applied to somewhat more glaucous populations from the Central and North Western Slopes of N.S.W. Further field study has shown the distribution of these and the coastal populations formerly known as *E. beyeri* to be much more continuous than previously thought, and we now regard the western populations as belonging to *E. beyeriana*.

Tree to 25 m tall. *Bark* persistent, dark grey ironbark, smaller branches sometimes smooth, grey. *Juvenile leaves* disjunct, petiolate, lanceolate to narrow-lanceolate, dull, slightly discolorous, to 7 cm long, 1.5 cm wide. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, acute or acuminate, dull green or grey-green, slightly discolorous or concolorous, amphistomatic, 6–12 cm long, 0.7–2.0 cm wide; petioles 10–20 mm long; lateral veins well-spaced, regular, at 40–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, c. 1 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots; peduncles 5–10 long; pedicels 4–8 mm long. *Mature buds* clavate, 3–5 mm long, 2–3 mm wide. *Calyptra* double; outer shedding early; inner shorter and narrower than hypanthium, hemispherical or broadly conical. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruit* broadly obconic or ovoid, 4–6 mm long, 3–6 mm diam.; stemonophore persistent; disc vertically depressed; valves deeply enclosed.

E. beyeriana is distinguished within the *E. paniculata* group by the narrow, dull adult and juvenile leaves and the small fruit.

The epithet recalls the fact that this species has been generally but mistakenly known as *E. beyeri* R. Baker, and in turn commemorates George Beyer (1865–1920) of the former Sydney Technological Museum, who assisted R.T. Baker.

30. Eucalyptus apothalassica *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. umbra* distinguitur: fructus parvi apice contracti, folia adulta parva plus concolores et amphistomatica, folia juvenilia disjuncta et caerulescentia.

TYPE: QUEENSLAND: on property 5 km S of Kogan on Tara Road (27°04'S 150°03'E), *K. Hill 1245 & L. Johnson*, 25.8.1984 (holo NSW; iso PERTH, BRI, CANB).

Tree to 15 m tall. *Bark* fully persistent, thin, long-fibrous. *Juvenile leaves* opposite, quickly becoming disjunct, broad-lanceolate to ovate, falcate, to 15 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate, glossy green, concolorous or very slightly discolorous, amphistomatic, 6–12 cm long, 1.2–2.6 cm wide; petioles flattened, 8–22 mm long; lateral veins regular, moderately spaced, at 30–45° to midrib, regularly reticulate between; intramarginal vein distinct, 1–2 mm from margin. *Inflorescences* axillary, often aggregated on short shoots to appear compound, umbellasters 11- or more flowered; peduncles terete, 8–14 mm long; pedicels 2–6 mm long. *Buds* ovoid to broadly fusiform (fully mature buds not seen). *Calyptra* appearing single, conical, acute to rostrate, as long as hypanthium. *Stamens* irregularly flexed, all fertile. *Fruit* globular-truncate, apically contracted, 4-locular, 5–7 mm long, 5–7 mm diam.; disc narrow (c. 0.5 mm wide), sunken, often obscured by incurved hypanthium; valves narrow, acute, sharply raised, the tips rim level or exserted. *Seeds* brown.

Distinguished from *E. umbra* R. Baker by the small, apically contracted fruit (6–8 mm long, 7–9 mm diam. in *E. umbra*), the small, more concolorous adult leaves (10–14 cm long, 2.5–3.5 cm wide in *E. umbra*), and the disjunct, bluish juvenile leaves. Fruit and bark resemble those of *E. acmenoides* Schauer, which is distinguished by the hypostomatic and very strongly discolorous adult leaves.

SELECTED SPECIMENS (from 14 examined): QUEENSLAND: Boolimbah Bluff, Carnarvon Gorge, *K. Hill*

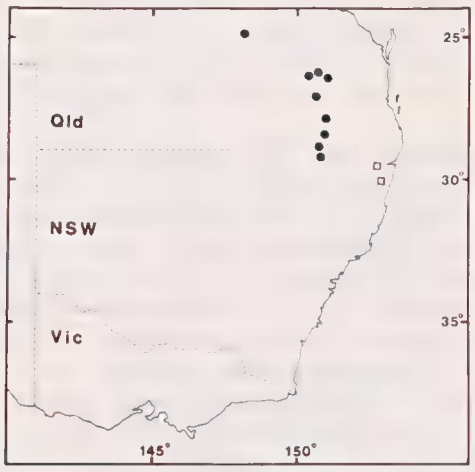

Figure 27. Distribution of *E. apothalassica* (circle) and *E. psammitica* (open square).

1330, 1.1.1986 (NSW); Mudwall block, Barakula State Forest, *M.I.H. Brooker 4785*, 17.4.1975 (CANB, NSW); Nudley forest reserve, 32 km N of Jandowae, *L. Johnson*, 5.6.1959 (NSW); Inglewood State Forest (28°24'S 151°02'E), *K. Hill 808 & L. Johnson*, 9.5.1984 (NSW). NEW SOUTH WALES: North Western Slopes: Bruxner Highway, near Bebo State Forest, *J. Benson*, 5.1986 (NSW).

DISTRIBUTION: A scattered and nowhere abundant species, extending from the Carnarvon Range in central Qld to the far North Western Slopes in N.S.W., north-east of Warialda (Figure 27).

ECOLOGY: A minor component of dry sclerophyll woodlands on sand accumulations or on shallow sand on sandstone. Associated species include *Callitris glaucophylla* J. Thompson & L. Johnson and *Eucalyptus chloroclada* (Blakely) L. Johnson & K. Hill.

The epithet is from the Greek *apo*, 'away from', and *thalassos*, 'the sea', from the distribution away from the coast (an unusual distribution within the white mahogany group).

CONSERVATION STATUS: Not considered to be at risk.

31. Eucalyptus psammitica *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. acmenoide* characteribus sequentibus differt: folia juvenilia latiora; folia adulta concoloria amphistomaticaque; fructus major. Ab *E. umbra* differt: folia juvenilia angustiora; discus fructus latus planusque eo *E. carneae* similis.

TYPE: NEW SOUTH WALES: North Coast: 3.2 km N of Coaldale on Grafton road, *R. Coveny 4985*, 23.8.1973 (holo NSW).

Tree to 15 m tall. *Bark* fully persistent, thin, long-fibrous. *Juvenile leaves* opposite, sessile, broad-lanceolate to ovate, green, discolorous, to 15 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate, glossy green, concolorous or very slightly discolorous, 8–18 cm long, 1.5–3.0 cm wide; petioles flattened, 12–20 mm long; lateral veins regular, moderately spaced, at 30–45° to midrib, regularly reticulate between; intramarginal vein distinct, 1–3 mm from margin. *Inflorescences* axillary, umbellasters 7–11-flowered; peduncles angular, 12–18 mm long; pedicels 3–6 mm long. *Buds* ovoid to broadly fusiform (fully mature buds not seen). *Calyptra* appearing single, conical, rostrate, as long as hypanthium. *Stamens* irregularly flexed, all fertile. *Fruit* globular-truncate, 4-locular, 8–10 mm long, 7–9 mm diam.; disc distinct, flat, c. 1 mm wide; valves broadly triangular, retracting laterally, tips remaining flat and enclosed. *Seeds* brown.

Distinguished from *E. acmenoides* Schauer by the broad-lanceolate juvenile leaves, the large fruit (to 7 X 7 mm in *E. acmenoides*), and the almost concolorous adult leaves. The narrower juvenile leaves and the broad, flat disc separate this taxon from *E. umbra* R. Baker (which has ovate juvenile leaves and a narrow, depressed disc). The fruit are most like those of *E. carnea* R. Baker, which is distinguished by its disjunct juvenile leaves.

SELECTED SPECIMENS (from 5 examined): NEW SOUTH WALES: North Coast: 0.9 km from the Grafton–Coaldale road on Stockyard Creek road, *K. Hill 2754, L. Johnson & P. Weston*, 19.10.1987 (MEL, NSW, PERTH, CBG), *K. Hill 793 & L. Johnson*, 7.5.1984 (NSW); 1.3 km N of Kremnos Creek, N of Glenreagh, *K. Hill 2741, L. Johnson & P. Weston*, 18.10.1987 (NSW).

DISTRIBUTION: Restricted to a belt of sandstone country running from north-west of Coffs Harbour to north-west of Grafton, N.S.W. (Figure 27).

ECOLOGY: Locally frequent in dry sclerophyll woodland on shallow sand on sandstone, often in association with *E. baileyana* F. Muell., *E. planchoniana* F. Muell. and *Angophora robur* L. Johnson & K. Hill.

The epithet is from the Greek *psammites*, 'sand', from the occurrence on sandy soils over sandstone.

CONSERVATION STATUS: 3V-. The poor sandstone outcrop habitat of this species would not be under immediate direct threat from pastoral activity. More field study is, however, required to evaluate the distribution and abundance of this taxon.

32. Eucalyptus stannicola *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. youmanii* characteribus sequentibus differt: folia alabastraque plus minusve glauca (sed haud pruinosa); pedunculi pedicellique longiores; alabastra minus angulata.

TYPE: NEW SOUTH WALES: North Western Slopes: 4.3 miles [6.8 km] S of Inverell, *R.D. Johnston & G.M. Chippendale 648*, 14.6.1968 (holo NSW; iso CANB).

Tree to 12 m high, often of irregular habit. *Bark* persistent throughout, long-fibrous, grey-brown ('stringybark'). *Seedling leaves* opposite for few nodes, variably lanceolate to ovate, a few sessile, hispid with hair tufts on emergent oil glands. *Juvenile leaves* disjunct, glabrous, ovate, to 12 cm long, 7 cm wide; petioles to 1.1 cm long. *Adult leaves* disjunct, similifacial, lanceolate, falcate, oblique, often slightly dull and somewhat bluish, 7–16 cm long, 1.3–3.2 cm wide; petioles to 1.9 cm long; lateral veins moderately spaced, regular, at 25–40° to midrib; reticulum even; oil glands large, sparse; intramarginal vein continuous, distinct, 0.5–2.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles flattened, 8–23 mm long, to 3 mm wide apically; pedicels angular, 1–5 mm long. *Mature buds* clavate to ovoid, angular, bluish, 5–7 mm long, 3–5 mm diam. *Calyptra* appearing single, hemispherical to conical, convex, acute or apiculate, about as long as hypanthium. *Fruit* hemispherical or globular, 3-locular, 8–12 mm long, 9–13 mm diam.; calyptra scar forming a concave band around fruit, 0.5–2.5 mm wide; stemonophore vertically raised, less than 0.5 mm wide; disc raised at 45–90°, ultimately flattened, 2.5–4.0 mm wide; valves broadly triangular, acute, basally enclosed, apically rim level to strongly exserted, raised at 45–90°. *Seeds* glossy, dark brown, angular, pyramidal, dorsally rounded, regularly very shallowly reticulate; hilum terminal; chaff pale brown.

E. stannicola differs from other species of the *E. youmanii* Blakely & McKie group in the more or less bluish leaves and buds, the longer peduncles and pedicels and the less angular buds. The buds and fruit are generally smaller, and the leaves narrower.

E. stannicola forms consistent populations, with some intergradation with *E. macrorhyncha* F. Muell. ex Benth. in the south of the range.

SELECTED SPECIMENS (from 20 examined): NEW SOUTH WALES: Northern Tablelands: Torrington, *R.H. Cambage 1824*, 30.9.1907 (NSW); 'Kelso', Kangaroo camp, *E.N. McKie & T. Youman*, 1.11.1929 (NSW); Longford to Bendemeer, *R.W. Jessup & A. Gray 3336*, 9.10.1951 (NSW). North Western Slopes: 20.3 miles [30.5 km] from Inverell towards Yetman, *M.I.H. Brooker 3937*, 28.2.1973 (CANB, NSW); 5.5 km S of Inverell on Tingha road, *P.H. Weston 1096, K. Hill & L. Johnson*, 20.10.1987 (NSW, PERTH, CANB, BRI); Tingha, *R.H. Cambage 962*, 14.10.1903 (NSW).

DISTRIBUTION: NEW SOUTH WALES: Western Northern Tablelands and eastern North Western Slopes, from Torrington to south of Tingha (Figure 28).

ECOLOGY: A locally dominant species on shallow coarsely sandy soils over the tin-bearing acid granites of this area, often in association with *E. andrewsii* Maiden and *E. prava* L. Johnson & K. Hill.

The epithet is from the Latin *stannum*, 'tin', *-cola*, 'an inhabitant', from the occurrence on 'tin granites'. The epithet is a noun in apposition, and its ending is not subject to change according to gender of the associated generic name.

CONSERVATION STATUS: Not considered to be at risk.

33. Eucalyptus williamsiana *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. youmanii* characteribus sequentibus differt: folia intermedia majora et orbicularia; folia adulta saepissime majora; alabastra fructusque majores.

TYPE: NEW SOUTH WALES: Northern Tablelands: 1.5 km E of W boundary of Gibraltar Range National Park on highway, *K. Hill 1278, L. Johnson & J. Williams*, 10.9.1985 (holo NSW; iso CANB, BRI).

Tree to 20 m high, often less, usually dense-crowned. *Juvenile leaves* disjunct, ovate to orbicular, 15 cm long, to 13 cm wide; hispid with hair tufts on emergent oil glands, becoming glabrous; petioles to 1.3 cm long. *Adult leaves* disjunct, similifacial, broad lanceolate, oblique, acute or acuminate, glossy dark green, 8–18 cm long, 1.6–5.0 cm wide; petioles to 2.3 cm long, thick, flattened or quadrangular; lateral veins moderately to widely spaced, regular, at c. 30° to midrib; reticulum incomplete; oil glands large, moderately densely spaced; intramarginal vein continuous, distinct, 1.5–4.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7–11-flowered; peduncles thick, angular, 3–12 mm long; pedicels thick, angular, 0–2 mm long. *Mature buds* angular, ovoid, 9–12 mm long, 6–7 mm diam. *Calyptra* appearing single, conical, convex, broadly apiculate, about as long as hypanthium. *Fruit* sessile, cup-shaped, 3–4-locular, 9–13 mm long, 10–15 mm diam.; calyptra scar vertically raised, forming a concave band around the fruit, 0.5–1.0 mm wide; stemonophore vertically raised, 0.2–0.5 mm wide; disc vertically raised, ultimately flattened, 3–5 mm wide; valves broadly triangular, obtuse, basally deeply enclosed, apically enclosed or rim level, raised at c. 45°. *Seeds* glossy, dark brown, angular, pyramidal, dorsally rounded, regularly shallowly reticulate; hilum terminal; chaff pale orange brown (Figure 29).

E. williamsiana differs from *E. youmanii* in the larger, orbicular intermediate leaves and generally larger adult leaves and the larger buds and fruit.

SELECTED SPECIMENS (from 24 examined): QUEENSLAND: c. 6 km NNE of Wallangarra, 1.8 km SSE of Mt Norman, *M.D. Crisp 7326, 7327 & I.R. Telford*, 28.9.1984 (AD, CBG, MEL, NSW); turnoff to Mt Norman, Girraween National Park, *N. Byrnes 4093*, 31.8.1982 (NSW, BRI, CANB). NEW SOUTH WALES: Northern Tablelands: Forestland State Forest, c. 15 miles [24 km] SSE of Tenterfield, *R.J. Turner NSW 30889*, 16.2.1955 (NSW); Chaelundi Mountain, hill on E side of road, *K. Hill 2736, L. Johnson & P. Weston*, 18.10.1987 (NSW); 4.6 km W of Armidale turnoff on Ebor–Guyra road, *J.D.*

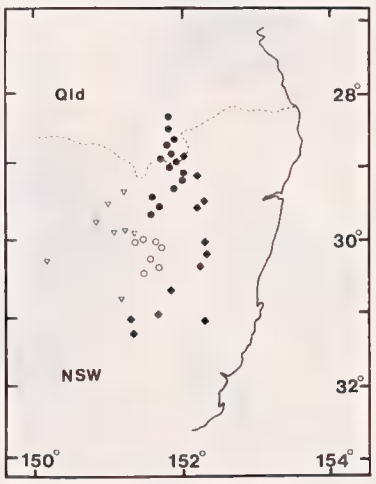

Figure 28. Distribution of *E. williamsiana* (diamond), *E. subtilior* (solid circle), *E. stannicola* (open triangle) and *E. youmanii* (open circle).

Briggs 11, 1.8.1977 (CANB, NSW); near Apsley Falls, *E.C. Andrews per R.H. Cambage 1217*, 5.1905 (NSW); Spokes Hill area, Mt Boss State Forest, *M.G. White*, 4.9.1957 (NSW); Campfire, via Niangala, *B. Small*, 10.1960 (NSW).

DISTRIBUTION: Sporadic, from the Wallangarra district in Queensland through the eastern ranges of the Northern Tablelands of N.S.W, from the Queensland border to the Niangala–Yarrowitch district (Figure 28).

ECOLOGY: Locally abundant in dry sclerophyll forests or woodlands, usually but not always on sandy soils over acid granite on the wetter range country of the eastern tablelands. Often associated with *E. campanulata* R. Baker & H.G. Smith, although on locally poorer sites.

The specific epithet honours John Beaumont Williams of the Botany Department of the University of New England, Armidale, whose comprehensive knowledge of the flora of the New England region has been of immense benefit to many visiting botanists, and

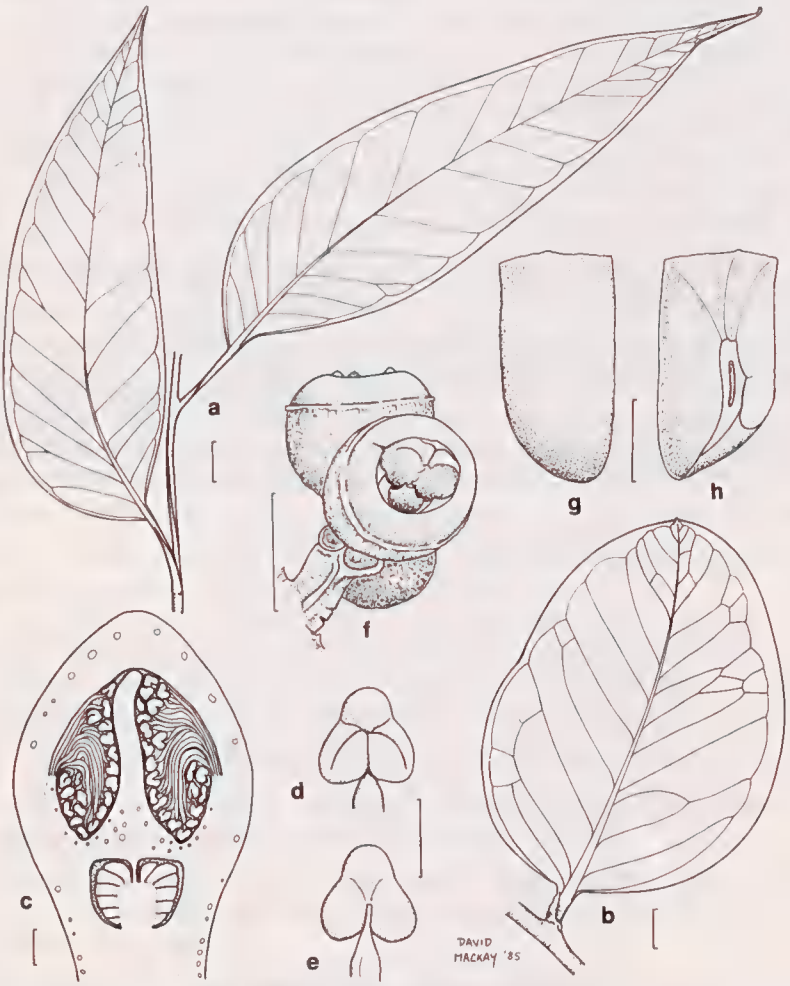

Figure 29. *E. williamsiana*. **a.**, adult leaves. **b.**, juvenile leaf. **c.**, median section of bud. **d.**, **e.**, anthers. **f.**, fruit. **g.**, **h.**, seeds (all from R.J. Turner NSW 30889). Scale bar: a,b,f = 1 cm; c,g,h = 1 mm; d,e = 0.5 mm.

who has contributed to understanding of perianth structure in the bloodwood group of eucalypts.

CONSERVATION STATUS: Not considered to be at risk.

34. Eucalyptus subtilior *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. youmanii* et *E. williamsiana* characteribus sequentibus differt: alabastra fructusque minores; folia juvenilia adultaque angustiora.

TYPE: QUEENSLAND: Ballandean, *S.T. Blake 20400*, 15.7.1958 (holo NSW; iso BRI, CANB, K, MO, SP).

Tree to 15 m high, often less, usually of irregular habit. *Bark* persistent throughout, long-fibrous, grey-brown ('stringybark'). *Seedling leaves* opposite for the first few nodes, broad-lanceolate, initially sessile, hispid with hair tufts on emergent oil glands. *Juvenile leaves* disjunct, broad-lanceolate, strongly oblique, glabrous, to 12 cm long, 4 cm wide;

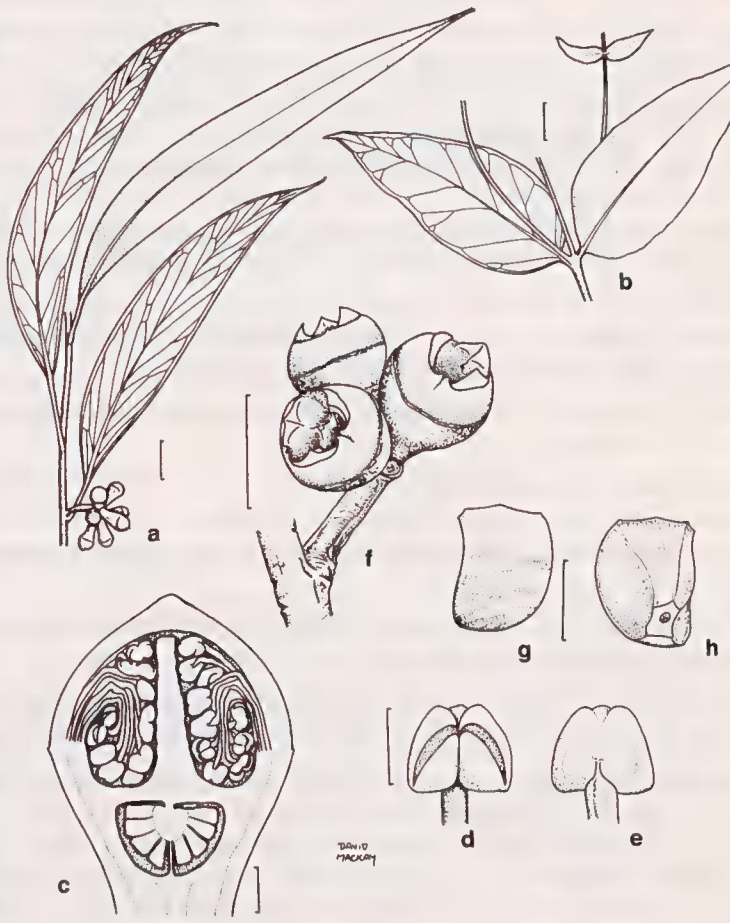

Figure 30. *E. subtilior.* **a.**A, adult leaves with buds. **b.**, juvenile leaves. **c.**, median section of bud. **d.**, **e.**, anthers. **f.**, fruit. **g.**, **h.**, seeds (all from *J.L. Boorman, 1.1918* except b, from *J.H. Simmonds, 27.10.1910*). Scale bar: a,b,f = 1 cm; c,g,h = 1 mm; d,e = 0.5 mm.

petioles to 1.2 cm long. *Adult leaves* disjunct, similifacial, lanceolate to broad-lanceolate, falcate, oblique, sometimes slightly bluish, 6–16 cm long, 1.1–2.3 cm wide; petioles to 1.6 cm long, quadrangular; lateral veins moderately spaced, regular, at 20–30° to midrib; reticulum even; oil glands large, moderately spaced; intramarginal vein continuous, distinct, 0.5–2.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles flattened, 4–11 mm long, to 0.25 cm wide; pedicels markedly angular, 0–2 mm long. *Mature buds* ovoid to clavate, 3–4-angled, usually dull and slightly bluish, 7–8 mm long, 3–4 mm diam. *Calyptra* appearing single, hemispherical or conical, convex, obtuse, slightly shorter than hypanthium. *Fruit* sessile, ± angular, cup-shaped or globular, 6–10 mm long, 7–12 mm diam.; calyptra scar and stemonophore raised, forming a concave band around the fruit; disc raised, ultimately flattened; valves broadly triangular, acute or obtuse, basally enclosed, apically exserted. *Seeds* glossy dark brown, angular, pyramidal or reniform, dorsally rounded; hilum ventral; chaff pale brown (Figure 30).

E. subtilior differs from *E. williamsiana* and *E. youmanii* in the smaller, often dull bluish buds, the smaller fruits, and the narrower juvenile and adult leaves.

SELECTED SPECIMENS (from 29 examined): QUEENSLAND: N of Dalveen, *S.T. Blake 20411*, 16.7.1958 (BRI, NSW); 17 km WSW of Stanthorpe, *L. Pedley A7422*, 27.3.1974 (CANB, NSW); Stanthorpe, *J.L. Boorman*, 1.1918 (NSW), *J.H. Simmonds*, 27.10.1910 (NSW); Wallangarra, *S.T. Blake 20395*, 14.7.1958 (BRI, CANB, MO, NSW). NEW SOUTH WALES: Northern Tablelands: Stoney Creek, c. 2 km S of Tenterfield, *D.F. Blaxell 1842*, 25.3.1981 (NSW); Sawyers Gully Road, W of Tenterfield, *M.I.H. Brooker 7282*, 3.3.1982 (CANB, NSW); 0.5 mile [0.8 km] N of Beardy Waters, N of Glen Innes, *L.A.S. Johnson & H.S. McKern*, 24.5.1957 (NSW); road to Rangers Valley, c. 10 miles [16 km] directly N of Glen Innes, *L.A.S. Johnson & D.J. McGillivray 2434*, 21.9.1966 (NSW).

DISTRIBUTION: Granite Belt district of Queensland, from Wallangarra to Stanthorpe, south through the central Northern Tablelands of N.S.W., from Wallangarra to near Glen Innes (Figure 28).

ECOLOGY: Locally abundant in dry sclerophyll woodlands, usually on sandy soils over granite, mostly on less infertile granites than *E. williamsiana*.

The epithet is from the Latin *subtilior*, 'more slender or delicate' (by comparison with *E. youmanii* and *E. williamsiana*).

CONSERVATION STATUS: Not considered to be at risk.

35. Eucalyptus youmanii *Blakely & McKie*, Proc. Linn. Soc. New South Wales 55: 590 (1930).

TYPE CITATION: 'Specimens from Rosehill, 6½ miles [10.4 km] SW. of Guyra (T. Youman, Rev. E.N. McKie, and W.F. Blakely, October, 1929) constitute the type'.

TYPE: holo NSW; iso K. Although cited as 'specimens', this collection comprises several pieces with one label in a single folder, and is hence accepted as a single collection.

Tree to 20 m high, usually dense-crowned. *Juvenile leaves* disjunct, broad-lanceolate to ovate, to 8 cm long, to 4.5 cm wide; hispid with hair tufts on emergent oil glands, becoming glabrous; petioles to 1.0 cm long. *Adult leaves* disjunct, similifacial, broad lanceolate, oblique, acute or acuminate, glossy dark green, 9–14 cm long, 1.6–3.5 cm wide; petioles to 2.0 cm long, thick, flattened or quadrangular; lateral veins moderately to widely spaced, regular, at c. 30° to midrib; reticulum incomplete; oil glands large, moderately densely spaced; intramarginal vein continuous, distinct, 1–2 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, angular, 8–15 mm long; pedicels thick, angular, 0–2 mm long. *Mature buds* angular, ovoid or fusiform, glossy, 8–10 mm long, 5–7 mm diam. *Calyptra* appearing single, conical,

convex, often angular, sometimes broadly apiculate, about as long as hypanthium. *Fruit* sessile, cup-shaped, 3–4-locular, 9–12 mm long, 8–15 mm diam.; calyptra scar raised at 45°-90°, forming a concave band around the fruit, 0.5–1.0 mm wide; stemonophore raised, to 0.5 mm wide; disc raised at 45°–90°, ultimately flattened, 2–4 mm wide; valves broadly triangular, obtuse, basally deeply enclosed, apically enclosed or rim level, raised at c. 45°. *Seeds* glossy, dark brown, angular, pyramidal, dorsally rounded, regularly shallowly reticulate; hilum terminal; chaff pale orange brown.

The removal of the above three species from *E. youmanii* substantially alters the circumscription of the latter. The notes on distribution and ecology together with the specimens cited here are intended to clarify the new, narrower circumscription of *E. youmanii*.

E. youmanii as defined here is distinguished by ovate to broad-lanceolate juvenile and intermediate leaves, glossy buds and sessile fruit. It is in general coarser than *E. subtilior*, less coarse than *E. williamsiana*, and disjunct from both.

Intergrading populations occur with *E. laevopinea* R. Baker, and hybrids are known with *E. stellulata* Sieber ex DC.

SELECTED SPECIMENS (from 19 examined): NEW SOUTH WALES: Northern Tablelands: 17.4 miles [27.8 km] from Guyra towards Tingha, *M.I.H. Brooker 3928*, 27.2.1973 (CANB, NSW); Hartmann's paddock, near S.F. 322, Llangothlin, *E.N. McKie 152*, 20.4.1928 (NSW); c. 7.5 miles [12 km] SW of Guyra, *E.N. McKie 146*, 7.6.1928 (NSW); 1.9 km E of New England Highway on Sunnyside road, turnoff 11 km N of Armidale, *M.I.H. Brooker 7260*, 2.3.1982 (CANB, NSW); Tea Tree Creek, c. 19 km W of Armidale on Bundarra road, *K. Hill 1306 & L. Johnson*, 12.9.1985 (BRI, CANB, NSW).

DISTRIBUTION: A restricted species, occupying a belt from Wandsworth to west of Uralla, on the Northern Tablelands of N.S.W. (Figure 28).

ECOLOGY: Often forming pure stands on shallow, poor soils. Richer clay soils on basalt in the same areas carry *E. caliginosa* Blakely & McKie.

CONSERVATION STATUS: 2V-. As now defined, this species is restricted mainly to productive grazing lands, and under considerable long-term threat.

36. Eucalyptus bensonii *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. camfieldii* characteribus sequentibus differt: folia juvenilia petiolata non cordata; fructus majores; alabastra longiora; folia adulta longiora angustioraque.

TYPE: NEW SOUTH WALES: Central Tablelands: Gospers Mtn fire trail, 8.2 km S of Mt Boonbourwa, *D.H. Benson 1406, K. Hill & L.A.S. Johnson*, 10.5.1983 (holo NSW).

Mallee to 8 m high, usually less than 6 m, rarely single-stemmed. *Bark* persistent, long-fibrous ('stringybark') on lower stems to c. 4 cm diam., smooth above. *Young stems* angular. *Juvenile leaves* opposite, becoming disjunct, ovate or elliptical, apiculate, to 6 cm long, 3.5 cm wide, petioles 4–10 mm long, with dense raised glands with radiating hairs, persisting for many nodes. *Adult leaves* disjunct, glabrous, coriaceous, broad-lanceolate, falcate, markedly oblique, obtuse and apiculate, 6–12 cm long, 2–3.5 cm wide, petioles 1–2 cm long; lateral veins indistinct, widely spaced, at 30–45° to midrib; intramarginal vein indistinct, 1–2 mm from margin. *Inflorescence* simple, axillary; umbellasters usually 11- sometimes 7-flowered; peduncles distinctly flattened, 7–12 mm long, to 5 mm wide apically. *Mature buds* sessile, oblong, distinctly 2- or 3-angled, 6–8 m long, 3.5–4.5 mm diam. *Calyptra* appearing single, rounded, angular, c. ½ as long as hypanthium. *Fruit* sessile, globular, 3- rarely 4-locular, 7–9 mm long, 8–12 mm diam.; calyptra scar a narrow groove; stemonophore indistinct, 0.5–1 mm wide, continuous with disc and hypanthium; disc domed, c. 2 mm wide, ultimately enclosing

valve bases; valves broadly triangular, angled inward, enclosed or partially exserted. *Seeds* dull, dark brown, angular, to 2 mm long; chaff similar, smaller, brown (Figure 31).

E. bensonii differs from *E. camfieldii* Maiden in the petiolate, non-cordate juvenile leaves, the larger fruit (to 9 mm diam. in the latter), the oblong buds and the broad-lanceolate adult leaves.

SELECTED SPECIMENS (from 7 examined): NEW SOUTH WALES: Central Tablelands: 18.2 km along Army Road from Coricudgy road, *K. Hill 2795 & L. Stanberg*, 12.5.1988 (NSW); 8.2 km S of Mt Boonbourwa on the road to Gospers Mountain, *D. Benson 1379,1380,1381 & D. Keith*, 21.4.1983 (NSW); sandstone butte between Glen Davis and Glen Alice, *P. Hitchcock 14*, 10.9.1977 (NSW).

DISTRIBUTION: NEW SOUTH WALES: Known from isolated occurrences in the area to the east of Rylstone and Glen Davis (Figure 32).

ECOLOGY: A heathland species, growing in areas of impeded drainage in highly dissected sandstone plateau areas, often in association with *E.* sp. nov. aff. *stricta* Sieber ex Sprengel, *E. multicaulis* Blakely and a range of scleromorphic shrubs.

Figure 31. *E. bensonii*. **a.**, adult leaves. **b.**, juvenile leaves. **c.**, twig with buds. **d.**, median section of bud. **e.**, **f.**, anthers. **g.**, fruit. **h.**, **i.**, seeds (all from *D.H. Benson 1406*). Scale bar: a,b,c,g = 1 cm; d = 4 mm; e,f = 0.5 mm; h,i = 1 mm.

The specific epithet honours Douglas Howard Benson, Ecologist with the National Herbarium of New South Wales, who drew attention to this taxon during a vegetation mapping program in the area in which it occurs.

CONSERVATION STATUS: 2VCt. The entire known occurrence of this species is in remote parts of the Wollemi National Park.

37. Eucalyptus conjuncta *L. Johnson & K. Hill*, **sp. nov.**

Inter species *E. eugenioidis* affines, combinatione sequenti distinguitur: folia adulta viridia concoloria; calyptra acuta sed breviuscula; fructus parvi vel mediocres cupuliformes in pedicellis longis gracilibusque.

TYPE: NEW SOUTH WALES: Central Western Slopes: 'Paradise Rocks', at top of ridge behind Murrurundi golf club, *K. Hill 1324*, 21.9.1985 (holo NSW; iso AD, BRI, CANB, CBG, K, MEL, MO, PERTH).

Tree to 15 m tall. *Bark* persistent to small branches, stringy. *Juveniles leaves* disjunct, lanceolate, crenulate, to 8 cm long, 1.5 cm wide, hispid with hair tufts on emergent oil glands. *Adult leaves* disjunct, concolorous, glossy bright green, lanceolate, 9–14 cm long, 1.2–2.2 cm wide; petioles 0.9–1.3 cm long; lateral veins at 30–45° to midrib. *Inflorescences* simple, axillary; umbellasters 11- or more flowered; peduncles slender, angular, 5–10 mm long; pedicels slender, terete, 1–4 mm long. *Buds* fusiform, 5–7 mm long, 2–3 mm diam. *Calyptra* appearing single, as long as or slightly shorter than hypanthium, conical. *Fruit* cup-shaped, 4–6 mm long, 6–8 mm diam.

Distinguished by the combination of concolorous green adult leaves, acute but relatively short calyptra, and small to medium-size cup-shaped fruits with long, slender pedicels.

This taxon is morphologically intermediate between *E. eugenioides* Sieber ex Sprengel and *E. sparsifolia* Blakely, which both occur in parts of the upper Hunter Valley, and may have originated as a hybrid population between the two and become stabilized. It is distinguished from *E. eugenioides* by the concolorous leaves and smaller fruit (to 8 mm long, 9 mm diam. in the latter), and from *E. sparsifolia* by the shorter calyptra, the longer, slender pedicels, and the cup-shaped fruit.

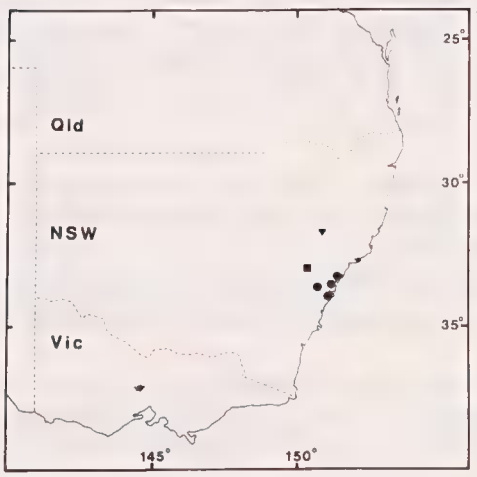

Figure 32. Distribution of *E. bensonii* (square), *E. conjuncta* (triangle) and *E. oblonga* (circle).

SELECTED SPECIMENS (from 9 examined): NEW SOUTH WALES: Central Western Slopes: 3 km NW of Murrurundi, on New England Highway, *L.A.S. Johnson 8715*, 1.2.1983 (NSW); 0.5 mile [0.8 km] W of Murrurundi, *R. Story 7468*, 7.10.1960 (CANB, NSW); Murrurundi, *E.J. Gregson*, 10.11.1954 (NSW); 3.5 km N of Murrurundi on New England Highway, *G.M. Chippendale 1232 & M.J. Brennan*, 10.4.1975 (CANB, NSW).

DISTRIBUTION: Known from a very restricted area around Murrurundi in the upper Hunter Valley, New South Wales (Figure 32).

ECOLOGY: Locally frequent in grassy or dry sclerophyll woodland on skeletal sandy soils on sandstone or conglomerate, usually on sloping sites or broken crests.

The epithet is from the Latin *conjunctus*, 'joined', in reference to the morphologically intermediate nature.

CONSERVATION STATUS: 2V-. Although most stands of this species are on privately held grazing land, there are occurrences in small reserves.

38. Eucalyptus oblonga *DC.*, Prodr. 3: 217 (1828).

TYPE CITATION: 'Sieb! plant. exs. nov.-holl. n. 583.'

TYPE: holo G-DC; iso BM, G, NSW.

= *E. deformis* Blakely, J. & Proc. Roy. Soc. New South Wales 61: 152 (1927).

TYPE CITATION: '. . . Kariong Trig. Station, the type locality, which is roughly about 7 miles [11 km] north of Brooklyn (D.W.C. Shiress and W.F.B.)'

TYPE: NEW SOUTH WALES: ½ mile [0.8 km] S of Kariong Trig, Wondabyne, *W.F. Blakely & D.W.C. Shiress NSW 222259*, 25.4.1927 (holo NSW, iso NSW). This specimen was labelled 'type' by Blakely.

Included in *E. oblonga* by Johnson (1962).

= *E. oblonga* DC. var. *rugulosa* Blakely, Key Eucalypts: 191 (1934).

TYPE CITATION: 'N.S.W. — Spring Gully Creek, Hornsby, W.F. Blakely, October, 1930.'

TYPE: holo NSW 222255.

E. oblonga was interpreted broadly to include *E. sparsifolia* by Pryor & Johnson (1971). We would now take a narrower view and regard the two as separate taxa, with a degree of intergradation. *E. oblonga* as now defined is a quite restricted taxon, occurring on skeletal soils on sandstone or on residual Tertiary laterites over sandstone, for the most part on the Ourimbah and Kuring-gai plateaux. Other small occurrences are in Royal National Park and on the edges of the Woronora Plateau, and in the Kedumba Valley (Figure 32).

Distinguished from *E. sparsifolia* by the ovate juvenile leaves, the broad-lanceolate adult leaves and the ovoid, acute buds. Buds and fruit usually very shortly pedicellate (pedicels less than 1.5 mm long).

Intergrading populations with *E. sparsifolia* and *E. capitellata* Sm. occur. Hybrids are known with *E. pilularis* Sm. (hybrids were named *E. wardii* Blakely) and *E. haemastoma* Sm.

SELECTED SPECIMENS (from 49 examined): NEW SOUTH WALES: Central Coast: Bill Jacks Point, Red Hill Rd, Ourimbah State Forest, *G.J. Power*, 11.1973 (NSW); Peats Ridge, S of Mangrove Mountain, *E.J. Gregson*, 9.5.1953 (NSW); 3.2 km NNE of Berowra on Pacific Highway, *G.M. Chippendale 1016 & R. Godenzi*, 30.5.1974 (CANB, NSW); S of Terry Hills, near head of Middle Creek, *L.A.S. Johnson 7225*, 14.6.1971 (NSW); Roseville Chase, *C. Burgess*, 9.5.1953 (NSW); Wises Track, Royal National Park, *R. Coveny 9663a*, 15.10.1977 (NSW); Bangor, *P. Moore*, 6.1986 (NSW); Waterfall, *J.H. Maiden*, 8.1906 (NSW).

CONSERVATION STATUS: Not considered to be at risk.

39. Eucalyptus sparsifolia *Blakely*, Key Eucalypts: 190 (1934), as 'sparsiflora' in text.

TYPE CITATION: 'N.S.W. — Glenore [sic], Maroota and Windsor districts, W.F. Blakely and D.W.C. Shiress, the type'.

TYPE: NEW SOUTH WALES: Glenorie to Canoe Grounds [now Canoelands], *W.F. Blakely & D.W.C Shiress NSW 222256, NSW 222257, NSW 222258*, 14.10.1927 (Lecto: NSW, 3 sheets, here designated). Although not so cited in the protologue, this collection was selected as 'type' by Blakely and clearly labelled as such, and can hence be accepted as the lectotype. The three sheets represent different phases of growth and flowering. The usage of 'sparsiflora' in the main text is clearly shown to be an unintentional error by the use of 'sparsifolia' in the key and in the index, and on all specimens annotated by Blakely.

This species has a wide range within N.S.W., from the Pilliga Scrub and upper Hunter Valley through the Central Western Slopes and Blue Mountains to the edges of the Cumberland Plain, with outliers in the upper Manning catchment (Figure 33). It occurs on sandy but somewhat more fertile and often deeper soils than *E. oblonga*.

E. sparsifolia is distinguished by the combination of linear juvenile leaves, narrow-lanceolate to lanceolate adult leaves and narrow-fusiform, acute buds. The calyptra is narrow-conical and frequently slightly longer than the hypanthium, and buds and fruit usually very shortly pedicellate (pedicels less than 1.5 mm long).

Intergrading populations occur with *E. eugenioides* Sieber ex Sprengel, *E. globoidea* Blakely, *E. oblonga* and *E. agglomerata* Maiden. Hybrids are known with *E. cannonii* R. Baker, *E. ligustrina* DC., *E. stellulata* Sieber ex DC., *E. sieberi* L. Johnson, *E. sclerophylla* (Blakely) L. Johnson & Blaxell and *E. racemosa* Cav.

SELECTED SPECIMENS (from 138 examined): NEW SOUTH WALES: North Coast: W of Vinegar Mtn, c. 35 km NW of Gloucester, *J. Benson*, 20.8.1980 (NSW); c. 200 metres from summit of Sugarloaf (W of Newcastle), *K. Hill 755 & L. Johnson*, 3.5.1984 (CANB, NSW); 6 miles [9.6 km] SE of Broke, *R. Story 7372*, 8.6.1960 (CANB, NSW). Central Coast: 5 km S of Bucketty, *J. Pickard 856*, 14.11.1970 (NSW); 6.8 km towards Sackville from Glenorie–Wisemans Ferry road, *G. Chippendale 1013 & R. Godenzi*, 29.5.1974 (CANB, NSW); Cheltenham, *L.A.S. Johnson 834*, 26.10.1946 (NSW); near golf links, Richmond Road, Springwood, *G. Chippendale 1196 & M.J. Brennan*, 7.4.1975 (CANB, NSW); Londonderry road, 2 km N of Penrith–Windsor road, *D.H. Benson 1205*, 9.6.1976 (NSW).

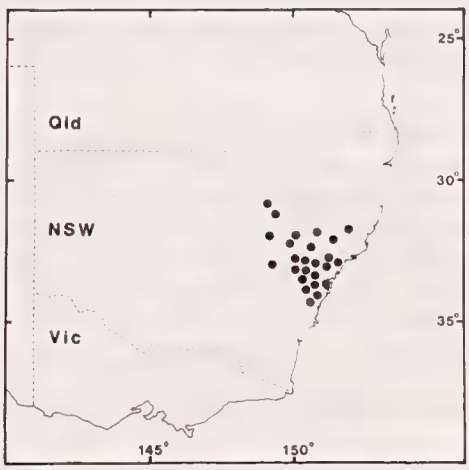

Figure 33. Distribution of *E. sparsifolia*.

Central Tablelands: 7 miles [11.2 km] E of Olinda, *L.A.S. Johnson*, 1.9.1951 (NSW); W slopes of Mt Darcy, *K. Hill 2799 & L. Stanberg*, 12.5.1988 (NSW, PERTH); NW corner of Mullion Range State Forest, *B. Lane NSW 47953*, 10.1959 (NSW); 2 miles [3.2 km] S of Capertee, *D.O. Cross*, 2.10.1938 (NSW); 3 km SE of Cullen Bullen towards Lithgow, *K.L. Wilson 2419 & J.T. Waterhouse*, 17.8.1979 (NSW); Mt Victoria, *E.F. Constable NSW 11298*, 20.3.1950 (NSW); Wentworth Falls, *L.A.S. Johnson 948/1*, 9.1948 (NSW). North Western Slopes: Baradine district, *F.M. Bailey NSW 6481*, 2.9.1948 (NSW). Central Western Slopes: 3.8 km from Cressfield Road on Middle Road, N of Scone, *K. Hill 1310*, 21.9.1985 (BRI, CANB, NSW, PERTH); 10 miles [16 km] SW of Murrurundi, *R. Story 6924*, 26.11.1959 (CANB, NSW); Lees Pinch, Wollar–Merriwa road, *L.A.S. Johnson NSW 17742*, 19.9.1951 (NSW); 1 km S of Caratel Loop, Dubbo–Merrygoen railway, *L.A.S. Johnson 7580*, 27.2.1973 (NSW).

CONSERVATION STATUS: Not considered to be at risk.

40. Eucalyptus radiata *Sieber ex DC.*, Prodr. 3: 218 (1828).

TYPE CITATION: 'Sieb! plant. exs. nov.-holl. n. 425.'

TYPE: New Holland, *F.W. Sieber 475*, 1823 (holo G-DC; iso BM, FI, G, K, L, NSW, W). The collection number was wrongly cited as 425 by de Candolle.

The northern race is recognised here as a separate subspecies (although the locality is not stated on the type specimen, Sieber was known to collect only around Sydney and on the nearby Central and Southern Tablelands. The type subspecies is therefore taken to be the Central Tablelands race.). In addition, we recognise *E. robertsonii* Blakely and *E. croajingolensis* L. Johnson & K. Hill as distinct taxa, and consider that some further subdivision of *E. radiata* at subspecific rank in the south of its range will probably be necessary in the future.

Key to subspecies

1 Juvenile leaves linear to lanceolate .....40A. subsp. **radiata**
1* Juvenile leaves broad-lanceolate .....40B. subsp. **sejuncta**

40A. Eucalyptus radiata *Sieber ex DC.* subsp. **radiata**

= *E. phellandra* R. Baker & H.G. Smith, Res. Eucalypts ed. 2: 280 (1920).

TYPE CITATION: '*Habitat.* — Barber's Creek, Batlow, Braidwood, Bundanoon, Bungendore, Burrawang, Crookwell, Hill Top, Laurel Hill, Lochiel, Marulan, Mittagong, Monga, Moss Vale, Tumberumba [sic], Tumut, New South Wales; Warburton, Victoria.' Material for oil distillation was cited as 'Monga, N.S.W., in July, 1898'.

TYPE: NEW SOUTH WALES: Moss Vale, *C.J. Clulee NSW 222263*, 22.11.1917 (lecto NSW, here designated). This specimen was annotated *E. phellandra* by Baker. Specimens collected by Clulee from Mittagong in 1921 were annotated 'taken from the tree at Mittagong from which the specimen supplied to Mr R.T. Baker on 22nd Nov. 1917 was obtained', and specimens collected in 1922 were annotated 'from the Type tree of *E. phellandra* '(after publication of the name). No specimen from Mittagong with this date exists, so the Moss Vale collection with the same date is selected as the lectotype.

Included in *E. radiata* by Maiden (*Crit. Revis. Eucalyptus* 7: 19).

= *E. australiana* R. Baker & H.G. Smith, J. & Proc. Roy. Soc. New South Wales 49: 514 (1916).

TYPE CITATION: None cited. The authors mention that their attention had been drawn to the tree by Mr W.T. Farrell in early 1913, who had collected specimens near Nerrigundah. However, no specimen relating to this statement can be found, and Baker

and Smith's publication of *E. amygdalina* var. *australiana* (as a *nomen nudum*) predates this.

TYPE: NEW SOUTH WALES: Monga, *W. Baeuerlen NSW 222261*, 7.1898 (lecto NSW, here designated). This is the only specimen located that was annotated *E. australiana* by Baker.

≡ *E. radiata* Sieb. ex DC. var. *australiana* (R. Baker & H.G. Smith) Blakely, Key Eucalypts: 211 (1934).

[*E. amygdalina* Labill. var. *australiana* R. Baker & H.G. Smith, Proc. & Trans. Roy. Soc. Tasmania: 201 (1912), nom. nud.]

Maiden (*Crit. Revis. Eucalyptus* 4: 230; *Crit. Revis. Eucalyptus* 8: 86) regarded this taxon as a mixture of specimens of *E. radiata* and *E. robertsonii*, and Blakely (1934) treated it as a variety of *E. radiata*. Pryor & Johnson (1971) treated it as a minor local variant of *E. radiata*.

= *E. radiata* Sieber ex DC. var. *subexserta* Blakely, Key Eucalypts: 211 (1934).

TYPE CITATION: 'N.S.W. — On limestone formation, McEwan's Creek, Jenolan Caves (W.F.Blakely, 18.7.1899; J.C.Wiburd, 11.1928).'

TYPE: NEW SOUTH WALES: Jenolan Caves, *W.F. Blakely NSW 222262*, 18.7.1899 (lecto NSW, here designated). Blakely had annotated this specimen 'Type' and the other cited specimen 'Cotype'. Since a 'Cotype' is now regarded as a Paratype, his Type is accepted as the lectotype.

DISTRIBUTION: Two disjunct occurrences are here included under *E. radiata* subsp. *radiata* (Figure 34). The first extends from the north-west of the Central Tablelands of New South Wales, from north of Rylstone, south through the eastern Southern Tablelands on to the higher western ranges of the far South Coast, but not extending into Victoria. The second is restricted to central Victoria, extending from the Dandenong Ranges west to about Ballarat.

Specimens are not cited for *E. radiata* subsp. *radiata*. Further study is required to

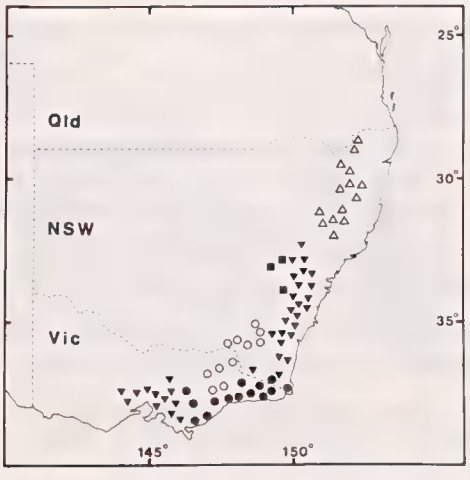

Figure 34. Distribution of *E. radiata* subsp. *radiata* (triangle) and subsp. *sejuncta* (open triangle), *E. robertsonii* subsp. *robertsonii* (open circle), and subsp. *hemisphaerica* (square), and *E. croajingolensis* (circle).

establish the nature of this taxon in southern New South Wales and central Victoria, and further subspecific division is likely.

Intergrading populations occur with *E. elata* Dehnh. and *E. willisii* Ladiges, Humphries & Brooker. Hybrids are known with *E. eugenioides* Sieber ex Sprengel, *E. globoidea* Blakely, *E. ligustrina* DC., *E. fastigata* Deane & Maiden, *E. pauciflora* Sieber ex Sprengel (hybrids = *E. vitrea* R. Baker), *E. stricta* Sieber ex Sprengel, *E. moorei* Maiden & Cambage, *E. sieberi* L. Johnson, *E. sclerophylla* (Blakely) L. Johnson & Blaxell, *E. rossii* R. Baker & H.G. Smith, and *E. dives* Schauer.

CONSERVATION STATUS: Not considered to be at risk.

40B. Eucalyptus radiata *Sieber ex DC.* subsp. **sejuncta** *L. Johnson & K. Hill,* **nom. et stat. nov.**

REPLACED NAME: *E. radiata* Sieber ex DC. var. *subplatyphylla* Blakely, Key Eucalypts: 212 (1934).

TYPE CITATION: 'N.S.W. — Aberfoyle Road, Guyra (Rev. E.N. McKie); six miles [9.6 km] south of Guyra; Butterleaf State Forest; Hanging Rock, Nundle, very common.'

TYPE: NEW SOUTH WALES: Aberfoyle Road, Guyra, *E.N. McKie NSW 222260,* 12.1932 (lecto NSW, here designated). This was the only specimen fully cited by Blakely, and the enclosing folder was annotated with the number of this taxon in his 'Key to the Eucalypts'.

Blakely's original epithet does not have priority in the changed rank of subspecies, is not particularly appropriate and is confusable with the name of the very different species *E. platyphylla* F. Muell.

Distinguished by the broad-lanceolate to narrow-ovate juvenile leaves.

The fruit is larger in more southern examples of subsp. *sejuncta,* possibly partly due to some introgression from *E. dives.*

Hybrids are known with *E. campanulata* R. Baker & H.G. Smith.

SELECTED SPECIMENS (from 44 examined): NEW SOUTH WALES: Northern Tablelands: Wilsons Downfall, *J.L. Boorman,* 11.1904 (NSW); c. 0.5 miles [0.8 km] E of Tenterfield towards Boonoo Boonoo, *M.I.H. Brooker 3952,* 2.3.1973 (CANB, NSW); c. 1 km from Paddys Gully road on Glencoe road, Backwater, *K. Hill 1334,* 21.1.1986 (BRI, CANB, NSW, PERTH); Marengo, *J.F. Campbell,* 3.1907 (NSW); 2.5 km E of Exmouth rail crossing, *K. Hill 1325,* 25.12.1985 (CANB, NSW, MEL, PERTH); Styx River S.F. road, 13.1 miles [20 km] from Armidale–Kempsey road, *M.I.H. Brooker 6073,* 23.1.1979 (CANB, NSW); 21.4 km E of Apsley Falls turnoff on Oxley Highway, *G.Chippendale 1258 & M.J. Brennan,* 12.4.1975 (CANB, NSW); 1 mile N of Glen Morrison, *L.A.S. Johnson NSW 222319,* 21.5.1957 (NSW); Kangaroo Tops, Tomalla Tableland, *H. McDonald 9,* 1.9.1954 (NSW).

DISTRIBUTION: Elevated eastern parts of the Northern Tablelands of New South Wales, from north-east of Tenterfield to the north-eastern Barrington Tops (Figure 34).

ECOLOGY: This taxon shows a scattered distribution in dry sclerophyll or grassy forests, usually on deeper and lighter soils in areas of moderately high rainfall. Very frequently associated with *E. campanulata* R. Baker & H.G. Smith.

The epithet is from the Latin *sejunctus* 'separate', in reference to the disjunct distribution from the other races of *E. radiata.*

CONSERVATION STATUS: Not considered to be at risk.

41. Eucalyptus croajingolensis *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. radiata* foliis adultis juvenilibusque latis, alabastris foliisque glaucis et disco fructus aliquantum latiore distinguitur. Ab *E. robertsonii* foliis adultis juvenilibusque latioribus et calyptra hemisphaerica distinguitur.

TYPE: VICTORIA: 20.5 km from Orbost on Bonang Highway, *K. Hill 1375, L. Johnson & D. Albrecht*, 18.2.1986 (holo NSW; iso CANB, MEL, PERTH).

Tree to 30 m tall. *Bark* fully persistent, dark grey, finely fibrous ('peppermint'). *Juvenile leaves* opposite, glaucous, sessile, ± cordate, oblong-elliptical, to 9 cm long, 3 cm wide. *Intermediate leaves* disjunct, ± glaucous, elliptical or broad-lanceolate, to 20 cm long, 5 cm wide, frequently appearing as reversions in crowns of mature trees. *Adult leaves* disjunct, usually broad-lanceolate, sometimes lanceolate, dull, distinctly bluish, 8–18 cm long, 1.2–4 cm wide, petioles flattened, 1.0–2.5 cm long. *Lateral veins* widely spaced, at 20–40° to midrib, reticulation open, with more than one oil gland per vein

Figure 35. *E. croajingolensis*. **a.** adult leaves. **b.** reversionary adult leaves with buds and flowers. **c.** twig with fruit. **d.** median section of flower. **e. f.** anthers. **g.** fruit (a, c, g from *C. Debenham, 3.1960*, b, d, e, f from *M.I.H. Brooker 7789*). Scale bar: a, b, c = 1 cm; d = 1 mm; e, f = 0.5 mm; g = 5 mm.

island. *Intramarginal vein* distinct, ± looped, 1–4 mm from margin, often with a distinct secondary intramarginal vein nearer the margin. *Inflorescences* simple, axillary; umbellasters 11- to more than 20-flowered; peduncles 4–15 mm long; pedicels 2–4 mm long. *Buds* glaucous, clavate, 3–5 mm long, 1.5–3 mm diam. *Calyptra* appearing single, hemispherical to patelliform, often finely apiculate, about half as long as hypanthium. *Fruit* 3–4-locular, globular-truncate, 4–6 mm long, 4–6 mm diam. *Calyptra* scar and stemonophore reduced to a fine line; disc level, c. 1 mm wide. *Valves* broadly triangular, enclosed or sometimes apically rim-level (Figure 34).

Distinguished from *E. radiata* by the broad-lanceolate, dull bluish adult and juvenile leaves, the glaucous buds and adult and juvenile foliage, and the somewhat broader, flatter disc in the fruit. Distinguished from *E. robertsonii* Blakely by the broad-lanceolate adult and juvenile leaves. The frequent appearance of broad, pendulous reversion leaves in mature undamaged canopy is a feature of this species.

Intergradation with *E. radiata* occurs on the eastern Southern Tablelands of New South Wales, and with *E. robertsonii* in parts of the Victorian highlands. There is apparently a sharp transition to *E. radiata* east of Melbourne.

SELECTED SPECIMENS (from 39 examined): NEW SOUTH WALES: South Coast: Timbillica, 200 metres E of homestead, *K. Hill 1364 & L. Johnson*, 17.2.1986 (CANB, NSW, PERTH, MEL); approach to Mt Imlay, *M.I.H. Brooker 6796*, 15.1.1980 (CANB, NSW). Southern Tablelands: The Gums, Bombala, *L.D. Pryor*, 30.3.1982 (NSW); Nalbaugh State Forest, *L.D. Pryor*, 30.3.1982 (NSW). VICTORIA: Poddy [as Poddys] Creek, on Princes Highway, *M.I.H. Brooker 7012,7013*, 26.10.1981 (CANB, NSW); 23 km W of Delegate on road to Tubbut, *L.D. Pryor & J.D. Briggs 212*, 8.2.1979 (CANB, NSW, MEL); Boggy Creek, Buchan road, *J.H. Maiden*, 7.1908 (NSW); c. 10 km along S Gippsland Highway towards Korumburra, *M.I.H. Brooker 7789*, 27.11.1982 (CANB, NSW); Between Sale and Longford, S Gippsland Highway, *C. Debenham*, 3.1960 (NSW); 4.4 km NNE of Yarram towards Traralgon, *G.M. Chippendale 988 & M.J. Beeston*, 2.5.1974 (CANB, NSW); 10.0 km W of Seaton, *K. Hill 1406, L. Johnson & D. Albrecht*, 19.2.1986 (NSW).

DISTRIBUTION: A species from the coastal side of the main divide, ranging from the far South Coast and Southern Tablelands of New South Wales (Bombala to Timbillica) through east Gippsland in Victoria, west to the vicinity of Mt Useful (Figure 34).

ECOLOGY: A species of sclerophyllous woodlands or forests on lighter soils in somewhat sheltered sloping sites on the coast and near-coastal ranges.

The epithet is from the district (and county) of Croajingolong, in East Gippsland. This name is deliberately clipped before adding the Latin suffix *-ensis*.

CONSERVATION STATUS: Not considered to be at risk.

42. Eucalyptus robertsonii *Blakely*, J. & Proc. Roy. Soc. New South Wales 61: 167 (1927), as *'robertsoni'*.

TYPE CITATION: 'Talbingo Mountain, Tumut district (A.W. Howitt, C.C. Robertson and W.A.W. de Beuzeville). The type.'

TYPE: NEW SOUTH WALES: Talbingo Mountain, near Tumut, *C.C. Robertson & W.A.W. de Beuzeville*, 9.1924 (holo NSW 132542). Blakely erroneously cited A.W. Howitt (who died in 1908) as a co-collector of the type with Robertson and de Beuzeville.

≡ *E. radiata* Sieber ex DC. subsp. *robertsonii* (Blakely) L. Johnson & Blaxell, Contrib. New South Wales Natl Herb. 4: 380 (1973).

The names *E. amygdalina*, *E. australiana*, *E. numerosa* and *E. phellandra* have all been applied to this taxon, although the types of all of these names belong to other taxa.

Distinguished within the *E. radiata* group by the combination of linear to narrow-lanceolate adult and juvenile leaves, glaucous leaves and buds, and (in the type

subspecies) the conical calyptra. This taxon has previously been included in *E. radiata*. We now regard it as sufficiently distinct to warrant recognition as one of several closely-related and rather narrowly-defined species composing the 'radiata group'.

The calyptra is shorter and rounded in northern populations of this species, which can on this basis be recognised as a subspecies.

Key to subspecies

1 Calyptra conical .....42A. subsp. **robertsonii**
1* Calyptra hemispherical .....42B. subsp. **hemisphaerica**

42A. Eucalyptus robertsonii *Blakely* subsp. **robertsonii**

Hybrids are known with *E. macrorhyncha* F. Muell., *E. pauciflora* Sieber ex Sprengel and *E. dives* Schauer (hybrids = *E. radiodives* R.A. Black).

SELECTED SPECIMENS (from 77 examined): NEW SOUTH WALES: Southern Tablelands: Batlow, *P. Murphy*, 3.1938 (NSW, *several sheets*); 9.5 km from Naas–Tharwa road on Honeysuckle Creek road (A.C.T.), *R. Coveny 11559 & P. Hind*, 20.1.1983 (CANB, NSW, K); 12 miles [19.2 km] E of Tumut, *M.I.H. Brooker 2968*, 10.3.1971 (CANB, NSW); 8.1 km from Cabramurra–Kiandra road on Ravine road (35°53'S 148°26'E), *K. Hill 738, L. Johnson & L. Pryor*, 27.4.1984 (CANB, NSW); Ingebyra, *A.B. Costin*, 6.11.1948 (NSW). VICTORIA: Porepunkah, *J.H. Leigh S 539*, 6.1.1968 (NSW); 6.4 km W of Mt Beauty towards Bright, *G.M. Chippendale 964 & M.J. Beeston*, 29.4.1974 (CANB, NSW); Glen Wills, and Glen Wills road, *H. Hopkins*, 1.8.1912 (NSW); 14 miles [22 km] from Corryong towards Omeo, *C.R. Dunlop CBG039648*, 4.1.1969 (CBG, NSW).

DISTRIBUTION: A taxon of somewhat sporadic occurrence but often quite abundant, mostly on the western fall of the Southern Tablelands of New South Wales south from around Batlow, and the inland side of the Great Dividing Range in Victoria between Mansfield and Omeo (Figure 34).

ECOLOGY: Usually in closed grassy woodlands in locally more sheltered sites.

CONSERVATION STATUS: Not considered to be at risk.

42B. Eucalyptus robertsonii *Blakely* subsp. **hemisphaerica** L . *Johnson & K. Hill*, **subsp. nov.**

A subspecies *robertsonii* calyptra hemisphaerica distinguitur.

TYPE: NEW SOUTH WALES: Central Tablelands: 1 km N of Mullion Creek on N of railway, *L.A.S. Johnson 8231 & B.G. Briggs*, 10.11.1975 (holo NSW; iso K, CANB).

Distinguished by the hemispherical calyptra.

SELECTED SPECIMENS (from 12 examined): NEW SOUTH WALES: Central Tablelands: Glengowan, Upper Meroo, *J.L. Boorman & A. Murphy 9966*, 1.1913 (NSW); 1.1 miles [1.8 km] NE of Mullion Creek, *R. Coveny 4170*, 15.4.1974 (NSW); W of Bocoble Mtn, *L.A.S. Johnson NSW 17737*, 9.11.1951 (NSW); Burraga, *F.W. Wakefield*, 3.7.1918 (NSW).

DISTRIBUTION: Central Tablelands of New South Wales, to the east and south-east of Orange (Figure 34).

ECOLOGY: Usually in closed grassy woodlands in locally sheltered sites.

The epithet is from the Latinised Greek *hemisphaericus*, 'hemispherical', referring to the calyptra.

CONSERVATION STATUS: 2V. Populations are localised and under some threat from pastoral activity.

43. Eucalyptus latiuscula *(Blakely) L. Johnson & K. Hill*, **comb. et stat. nov.**

BASIONYM: *E. moorei* Maiden & Cambage var. *latiuscula* Blakely, *Key Eucalypts*: 207 (1934).

TYPE CITATION: 'N.S.W. — On the eastern side of the forest Dividing Range, head of Tuross River, about 16 miles [25.6 km] easterly from Nimitybelle [Nimmitabel], N.S.W. (R.H. Cambage, No. 1981).'

TYPE: holo NSW; iso CANB.

E. latiuscula is intermediate between *E. stellulata* Sieber ex DC. and *E. moorei* Maiden & Cambage. It differs from *E. stellulata* in the smaller, lanceolate adult leaves and the mallee habit; and from *E. moorei* in the ovate juvenile leaves and lanceolate adult leaves (both juvenile and adult leaves are linear to narrow-lanceolate in *E. moorei*), the near-sessile umbellasters and the stouter, fewer-stemmed habit. No intergrading forms are known (Figure 36).

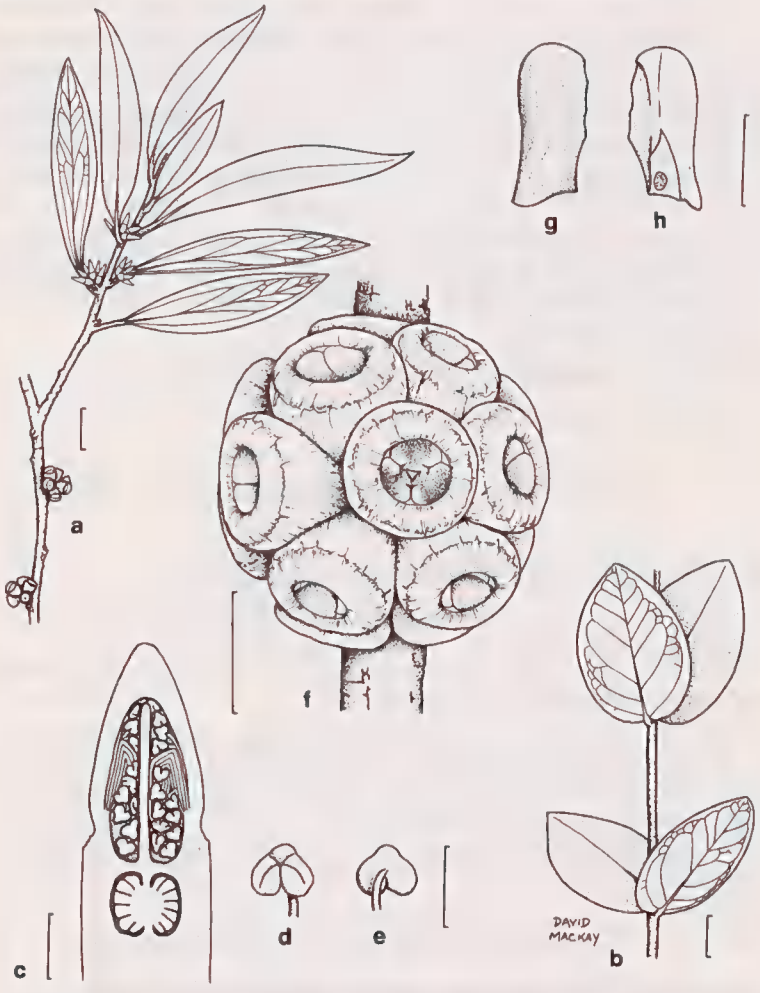

Figure 36. *E. latiuscula*. **a.** adult leaves, buds and fruit. **b.** juvenile leaves. **c.** median section of bud. **d., e.** anthers. **f.** fruit. **g., h.** seeds (all from *J.D. Briggs 206*). Scale bar: a, b = 1 cm; c, g, h = 1 mm; d, e = 0.5; mm f = 5 mm.

Confusion has surrounded the name *latiuscula* due to the inclusion of broad-leaved individuals and hybrids of *E. moorei* in the original circumscription of *E. moorei* var. *latiuscula*. As recognised here, the two are distinctly geographically separated, and are defined also on distinct differences in juvenile leaf characters that do not overlap.

SELECTED SPECIMENS (from 20 examined): NEW SOUTH WALES: Southern Tablelands: Tinderry Range, c. 1.5 km N of road, *K. Hill 1349 & L. Johnson*, 16.2.1986 (CANB, MEL, NSW, PERTH); c. 500 metres S of southernmost peak on the main Tinderry Range, *J.D. Briggs 206, 207, 208*, 1.8.1978 (CANB, NSW); 13.9 km from Countegany–Kybean road on Wadbilliga trig. road, *K. Hill 1355 & L. Johnson*, 16.2.1986 (CANB, MEL, NSW, PERTH); Nalbaugh National Park, White Rock Plateau, between Mt Wog Wog and White Rock, *D.E. Albrecht 1637*, 26.3.1985 (NSW, MEL).

DISTRIBUTION: Southern Tablelands of New South Wales, small populations on the Tinderry Range, Wadbilliga Mountain and White Rock Mountain (Figure 37).

ECOLOGY: An uncommon species, occurring in small populations on shallow soil with impeded drainage, in sclerophyllous scrub or sclerophyll woodland communities. Associated species include *E. pauciflora* Sieber ex Sprengel, *E. kybeanensis* Maiden & Cambage, *E. nitens* (Deane & Maiden) Maiden, *E. fraxinoides* Deane & Maiden, *E. paliformis* L. Johnson & Blaxell and *E. glaucescens* Maiden & Blakely.

CONSERVATION STATUS: 3RC. Almost all populations are in remote areas within national parks.

44. Eucalyptus olida *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. campanulata* characteribus sequentibus differt: folia juvenilia minora, rotundiora; fructus majores, cupuliformes; cortex crassior et mollior.

TYPE: NEW SOUTH WALES: Northern Tablelands: 4.2 km from the Gwydir Highway on the north-west fire trail, Gibraltar Range Natl Park (29°31'S 152°15'E), *K. Hill 1276 & L. Johnson*, 10.9.1985 (holo NSW; iso CANB, MEL).

Tree to 30 m tall. *Bark* persistent, thick, flaky-stringy, orange-brown; smaller branches smooth, grey. *Juvenile leaves* disjunct, petiolate, ovate or elliptical, falcate, twisted vertically, apically rounded and often finely apiculate, to 7 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate, falcate, grey-green, dull to semiglossy,

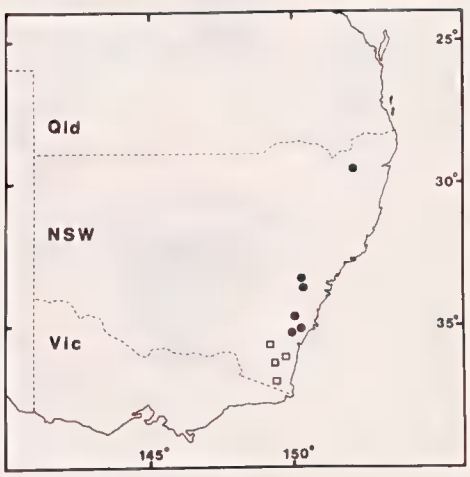

Figure 37. Distribution of *E. moorei* (circle) and *E. latiuscula* (open square).

8–17 cm long, 1.2–2.6 cm wide; lateral veins moderately spaced, at 30–50° to midrib; intramarginal vein distinct, 1–2 mm from margin. *Inflorescences* simple, axillary; umbellasters 7–11-flowered; peduncles 8–18 mm long; pedicels 2–6 mm long. *Buds* clavate, 3–5 mm long, 2–3 mm diam. *Calyptra* appearing single, persistent to anthesis, shorter than hypanthium, hemispherical, often finely apiculate. *Filaments* irregularly flexed, of equal length; anthers all fertile, reniform, dehiscing by confluent slits. *Style* long (touching calyptra in bud). *Fruit* campanulate to cup-shaped, 4-locular, 5–8 mm long, 5–7 mm diam.; calyptra and stamen scars flat, to 0.5 mm wide, continuous with disc; disc flat to slightly depressed, 1–1.5 mm wide, often glossy reddish-brown; valves enclosed. Seeds black, reniform or D-shaped; chaff similar in shape, brown, smaller (Figure 38).

Distinguished from *E. campanulata* R. Baker & H.G. Smith by the smaller, ovate and apically rounded juvenile leaves, the larger, more cup-shaped fruit (to 6 mm long, 5 mm diam. in *E. campanulata*), and the thicker, softer persistent bark. The distinctive odour (see below) is lacking in the former species. The leaves of *E. olida* also have

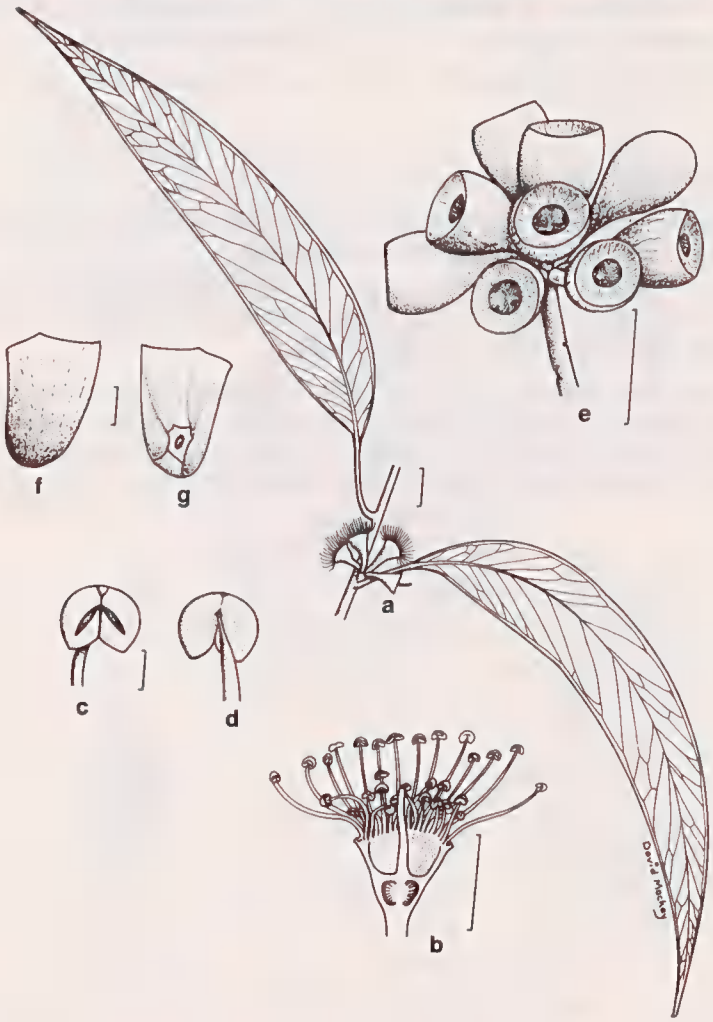

Figure 38. *E. olida*. **a.** adult leaves with flowers. **b.** median section of flower. **c., d.** anthers. **e.** fruit. **f., g.** seeds (all from *A.G. Floyd 833*). Scale bar: a, e = 1 cm; b = 5 mm; c, d = 0.5 mm; f, g = 1 mm.

smaller and more numerous stomata, and less acute venation than those of *E. campanulata*.

This taxon has been known for some time by forestry workers in the Tenterfield district, who recognised two sympatric taxa from the Timbarra Plateau as 'blackbutt' (*E. campanulata*) and 'swamp mahogany' (*E. olida*). It was also independently discovered by Ian Southwell of the New South Wales Department of Agriculture, who recognised two very different essential oil types in specimens collected as *E. campanulata* from the Gibraltar Range (pers. comm., Curtis, Southwell & Stiff 1990). *E. olida* has since been shown to carry a substantial quantity of methyl cinnamate in the leaves, a compound otherwise very restricted in the eucalypts. This is responsible for the distinctive pungent odour to which the specific epithet alludes. The species is probably not particularly closely related to *E. campanulata* or *E. andrewsii* Maiden, but its closest affinities are as yet uncertain.

SELECTED SPECIMENS (from 19 examined): NEW SOUTH WALES: Northern Tablelands: 3 km N of Poverty Point, *A.G. Floyd 833*, 18.1.1978 (NSW); 16.2 km from Bruxner Highway on Poverty Point road (29°02'S 152°15'E), *K. Hill 1281 & L. Johnson*, 10.9.1985 (NSW); 6.5 km NNW of Surface Hill (29°04'S 152°15'E), *D.J. Wood 11*, 3.10.1984 (NSW); Mulligans Hut region, Gibraltar Range National Park, *I. Southwell H85–026*, 17.9.1985 (NSW).

DISTRIBUTION: Known from two disjunct populations, on the Gibraltar Range and on the Timbarra Plateau ('Poverty Point'), in the eastern Northern Tablelands of N.S.W. (Figure 39).

ECOLOGY: A component of sclerophyllous forests on infertile, moderately deep, coarsely sandy soils on siliceous 'acid' granites, often but not always in lower sites or near (but not in) swamps. Associated with *E. ligustrina* DC., and in both areas occurring in a mosaic with *E. campanulata* – *E. cameronii* Blakely & McKie forests on slightly more fertile soils.

The epithet is from the Latin *olidus*, 'smelling' or 'rank', in reference to the distinctive, pungent and unpleasant odour of the leaf oils.

CONSERVATION STATUS: 3RC. Extensive populations occur in Gibraltar Range National Park.

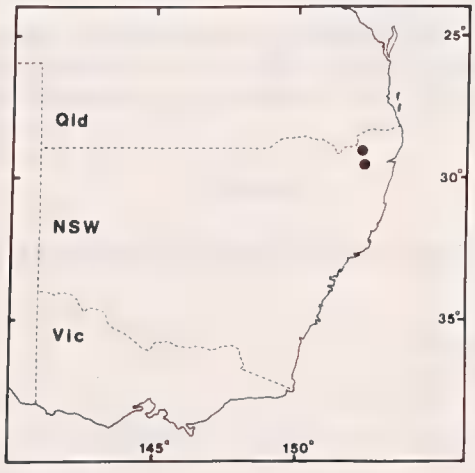

Figure 39. Distribution of *E. olida*.

Acknowledgements

Thanks are due to Leonie Stanberg, who has provided invaluable assistance through the project and drafted the distribution maps. David Mackay prepared the excellent illustrations. Our colleague in the overall project, Don Blaxell, has contributed helpful discussions on many points and has been involved in the recognition of several of the taxa. Lani Retter provided much assistance in earlier stages of the investigations. The work was in part supported by grants from the Australian Biological Resources Study, which are gratefully acknowledged, as are the facilities made available to the senior author by Professor Carrick Chambers, Director of the Royal Botanic Gardens.

References

Anderson, R.H. (1956) *The Trees of New South Wales*, 3rd ed. (Govt. Printer: Sydney).

Bentham, G. (1867) *Flora Australiensis*, vol. 3 (L. Reeve: London).

Blake, S.T. (1953) Botanical contributions of the northern Australia regional survey — I. Studies on northern Australian species of *Eucalyptus*. *Austral. J. Bot.* 1: 185–352.

Blakely, W.F. (1934) *A Key to the Eucalypts*. (The Worker Trustees: Sydney).

Briggs, J.D. & Leigh, J.H. (1988). *Rare or Threatened Australian Plants*. Australian National Parks and Wildlife Service: Special Publication 14.

Brooker, M.I.H. (1988) *Eucalyptus foecunda* revisited, and six related new species (Myrtaceae). *Nuytsia* 6(3): 325–334.

Brooker, M.I.H. & Hopper, S.D. (in press) A taxonomic revision of *Eucalyptus wandoo* Blakely, *E. redunca* Schauer, and allied species (*E.* series *Levispermae* Maiden — Myrtaceae) in Western Australia. *Nuytsia*.

Brooker, M.I.H & Kleinig, D.A. (1983) *A field guide to* Eucalyptus *Volume 1* (Inkata Press: Melbourne).

Chappill, J.A. (1988) *A systematic study of* Eucalyptus *L'Hérit. informal subgenus* Symphyomyrtus *section* Maidenaria *(Myrtaceae)*. (University of Melbourne: unpublished PhD thesis).

Chippendale, G.M. (1988) *Flora of Australia Volume 19,* Eucalyptus, Angophora *(Myrtaceae)* (Australian Government Publishing Service: Canberra).

Curtis, A, Southwell, I.A. & Stiff, I.A. (1990) *Eucalyptus*, a new source of methyl cinnamate. *J. Essential Oil Research* 2: 105–110.

Johnson, L.A.S. (1962) Studies in the taxonomy of *Eucalyptus*. *Contrib. New South Wales Natl Herb.* 3: 103–126.

Johnson, L.A.S. & Briggs, B.G. (1984) Myrtales and Myrtaceae — a phylogenetic analysis. *Ann. Missouri Bot. Gard.* 71: 700–756.

Maiden, J.H. (1903–33) *A Critical Revision of the Genus* Eucalyptus. (Govt. Printer: Sydney).

McVaugh, R. (1968) The genera of American Myrtaceae — an interim report. *Taxon* 17: 354–418.

Pryor, L.D. & Johnson, L.A.S. (1971) *A Classification of the Eucalypts*. (ANU Press: Canberra).

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Acacia blayana, a new species from the South Coast of New South Wales (*Acacia* sect. *Botrycephalae:* Fabaceae)

Mary D. Tindale and A.B. Court

Abstract

Tindale,[1] Mary D., and Court,[2] A.B. ([1] Royal Botanic Gardens, Sydney, N.S.W. 2000; [2] 71 Miller Street, O'Connor, A.C.T. 2601, formerly Australian National Botanic Gardens, Canberra City, A.C.T. 2601) 1990. Acacia blayana, *a new species from the South Coast of New South Wales (*Acacia *sect.* Botrycephalae: *Fabaceae). Telopea 4(1): 109–113.* A new bipinnate species of *Acacia* from south-eastern New South Wales, Australia, is described and illustrated. Its putative relationships are presented. A key is provided to *A. blayana* Tind. & Court and allied species.

Introduction

A new species of *Acacia* is described, prior to the forthcoming volume 2 of the Flora of New South Wales.

Taxonomy

The terminology of shapes in the specific description is that defined by Lee (1948: 144).

Acacia blayana *Tind. et Court*, **sp. nov.**

Acacia blayana affinis *A. pruinosae* Cunn. ex Benth. a qua differt habitu arborescenti (arbor usque ad 25 m), ramulis angularibus, pinnulis pubescentibus, 10–30 mm longis, calycibus 0.8–1.3 mm longis, corollis 1.8–2.0 mm longis, seminum pleurogrammate late aperto; affinis *A. schinoides* Benth. a qua differt pinnulis puberulis et glande orbiculari singula basi pinnarum parum omnium.

HOLOTYPUS: NEW SOUTH WALES: Brogo River Catchment, Galoon Creek, 22.5 km WSW of Cobargo, 36°27′ S, 149°39′ E, gully, pure stand in *Eucalyptus* forest, tree to 25 m, *J. Blay CBG 8213173*, ix.1982 (NSW). *Isotypi*: CBG, K, MEL, PERTH, USDA.

Tree to 25 m high, d.b.h. to 36 cm; *crown* small and open; *bark* dark grey. *Branchlets* green, brown or purplish, mostly glaucous, angular towards their apices, glabrous or almost so except towards their apices, puberulous with appressed white hairs 0.1–0.2 mm long, lenticels not prominent. *New leaves* at tip of branchlets whitish. *Leaves* bipinnate, glaucous, 17–18 cm long, 8–10 cm wide; *pulvinus* basal, glabrous or ± puberulous, green or dark brown, 2–5 mm long; *petiole* 2.0–5.5 cm long, ridged, slightly flattened vertically, sparsely puberulous towards the apex; *rhachis* 1.5–6.0 cm long, ridged, ± flattened vertically, with a central trough, ± puberulous, bearing orbicular, greyish brown to dark brown, ± puberulous or glabrous glands 0.8–1.2 mm long each with a cream-coloured orifice, at the base of each pair of pinnae, the gland near the lowest pair often slightly elongated and rarely to 6 mm below the latter pair on the petiole; *terminal seta* ± oblong or deltate, 0.6–0.8 mm long, straight or curved, bearing a minute orbicular gland; *pinnae* (2–)3–4 pairs, 4.0–9.5 cm long, 2.0–3.6 cm wide;

pinnules (7–)12–13 pairs, (1–)1.5–3.0 cm long, (1.5–) 3–4 mm wide, very narrowly elliptical-oblong, the proximal margin more curved than the distal, clothed on both surfaces with white, ± appressed, straight or curved hairs 0.1–0.2 mm long, with a prominent nerve in the upper third of the pinnule and 2 ± parallel minor nerves which do not reach the margin; *apex* broadly rounded or sometimes truncate, with a mucro less than 0.1 mm long; *margin* often dark red in the upper 1/3 of the pinnule, the base slightly narrowed. *Capitula* of 12–20 flowers, borne in 7–15-branched racemes, arranged in terminal panicles or arising in the upper axils of the leaves, golden yellow, globose, 5–9 mm diam.; *peduncle* glabrous except minutely puberulous towards the apex, 3.5–5.0 mm long; *bracts* at the base of each peduncle, ± oblong, hooded, dark brown, ciliolate along the margins; *bracteoles* composed of a claw 0.8–1.0 mm long and a peltate lamina 0.6–0.7 mm diam., both ciliolate with a fringe of white hairs. *Flowers* 5-merous; *calyx* 1.0–1.3 mm long, paler towards the apex, dissected to ⅓–⅕ of the length of the tube, glabrous or clothed with curled, hyaline hairs sometimes extending to the base of the tube; *corolla* 1.8–2.0 mm long, deeply dissected into glabrous, incurved, broadly rounded petals; *stamens* 3.0–5.3 mm long; *ovary* ± oblong or elliptical-oblong, black, c. 0.6 mm long, c. 0.4 mm wide, clothed with few to many white hairs; *style* acentral or median. *Legumes* linear, 6.0–11.2 cm long, 0.7–1.0 cm wide, straight or falcate, glabrous, brown, dark blue or purplish brown, the surface finely but not prominently reticulate, very slightly constricted between the seeds, slightly convex over the seeds, the margin light brown, c. 0.5 mm wide. *Seeds* 6–12, longitudinal in the legume, oblong-ellipsoid to almost round, dorsiventrally flattened, 4–6 mm long, 3.0–3.5 mm wide, black, slightly glossy; *pleurogram* ± prominent, U-shaped, widely open towards the hilum; *areole* black, raised, 3.5–4.5 mm long, 1.0–1.5 mm wide; *funicle* light brown, filiform, broadening into a cupuliform aril beneath the seed (Figure 1). *Flowering*: September–early October. *Fruiting*: late December–February. The legumes probably take about 3–5 months to mature.

DISTRIBUTION: *A. blayana* has a very restricted distribution occurring on the eastern side of the Great Dividing Range in Wadbilliga National Park on the South Coast of New South Wales, at approximately 200–600 m altitude (Boland & Midgley 1983), in skeletal rocky soils, in steep mountainous country in almost pure stands or with *Acacia mearnsii* De Wild. It occurs in tall open-forests with *Eucalyptus obliqua* and other eucalypts and *Tristaniopsis laurina*. This species has also been recorded (*L. Thomson 118*, FRI, CBG, NSW) from Violet Hill, 21.8 km N of Bega, South Coast, N.S.W., on the Princes Highway, where it is growing adjacent to a Dept of Main Roads gravel dump and is likely to have been introduced. At Galoon Creek on the alluvial terraces *A. blayana* occurs with *Acmena smithii*, but on the steep exposed slopes above the creek it is a smaller tree 6–10 m high found in scrub with *Eucalyptus wilcoxii* on metamorphosed rocks in skeletal soil (P. Gilmour & C. Helman, pers. comm.) (Figure 2).

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: South Coast: Galoon Creek, Wadbilliga National Park, *D.J. Boland 1888*, 14.ii.1983 (CBG 8302001, NSW); c. 1 km E of junction of Yankeys Creek and Brogo River, 36°29′ S, 149°37′ E, *P. Cope CBG 8203158*, 1.vii.1982 (CBG, NSW); N of Bemboka on the Nelsons Creek Trail, 36°29′ S, 149°40′ E, *B.V. Gunn BG 621*, 8.i.1985 (FRI, NSW); 15.6 km from Yankeys Gap along the Nelsons Creek fire trail, *E.G. Cole 1474*, 4.ii.1984 (CANB, NSW); 15.5 km along Nelsons Creek fire trail from junction with Yankeys Flat fire trail on W side of road, 36°29′ S, 149°40′ E, *G. Butler 1368*, 2.ii.1984 (CBG).

The specific epithet honours the conservationist John Blay, who made the original collections of this species. In 1981 he trekked through the rugged mountains west of Bermagui, N.S.W., for 9 months with his mule, Zac. Mr Blay's travels in this wilderness are described in his book (1987).

A. blayana belongs to a group of species in sect. *Botrycephalae* characterized by longer (1.0–2.7 cm) and wider (2–5 mm) pinnules than the majority of taxa in this section.

Figure 1. *Acacia blayana*. **a.** leaf and inflorescence (x ⅔). **b.** apex of pinna with 2 pairs of pinnules (x 1 ⅔). **c.** gland of rhachis (x 9). **d.** capitulum in bud (x 4). **e.** 2 bracteoles (x 13 ⅓). **f.** flower (x 13 ⅓). **g.** ovary (x 13 ⅓). **h.** legume (x ⅔). **i.** seed (x 3). *Vouchers:* a-g, *I.R. Telford 10410;* h-i, *Lex Thomson* 118. All figures drawn by B. Maloney.

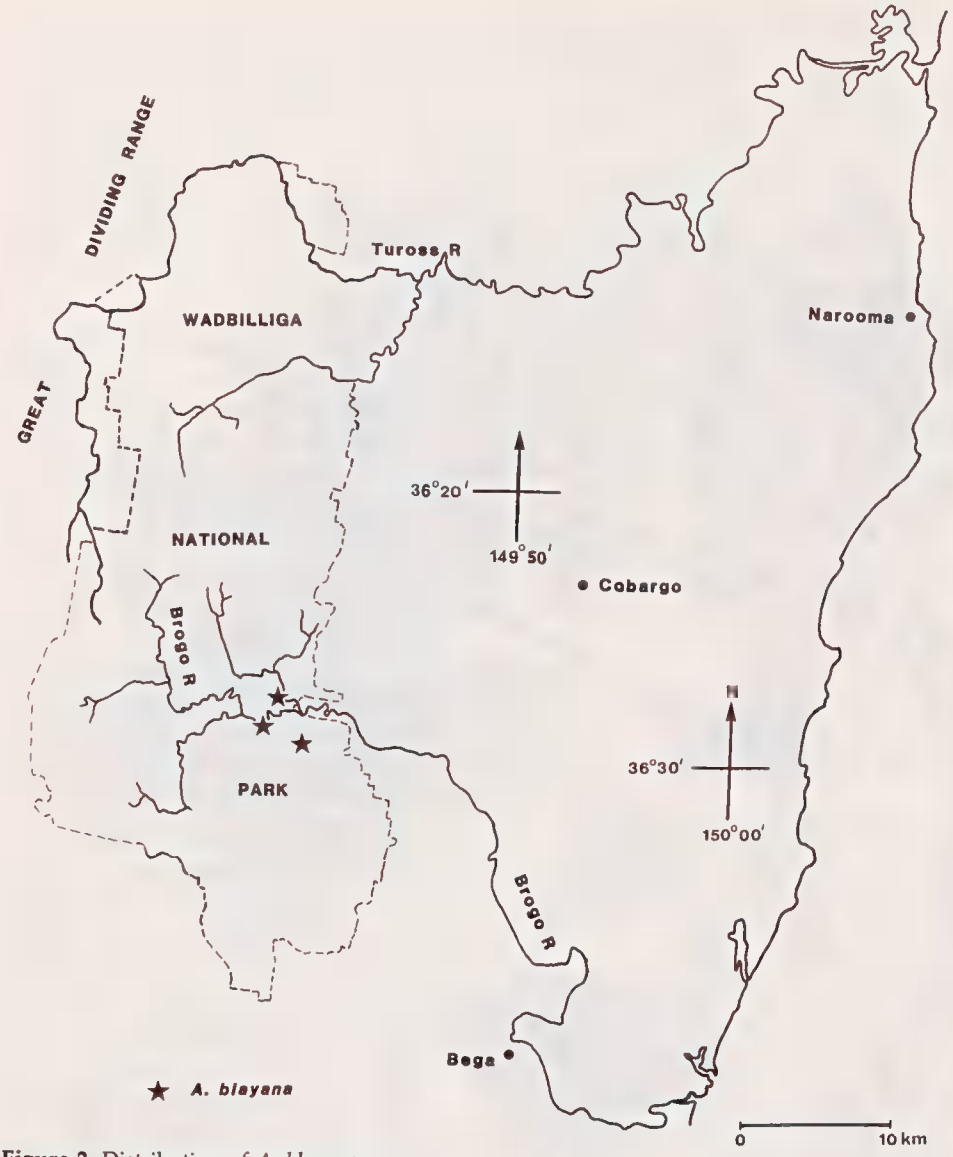

Figure 2. Distribution of *A. blayana*.

Key to *A. blayana* and allied species

1 Pinnules puberulous. Flowers golden, 12–20 in each capitulum. Ovary pubescent. [Rhachis with an orbicular gland at the base of each pair of pinnae, the gland below the lowest pair often slightly elongated and rarely up to 6 mm below the lowest pair. Tree to 25 m high] ..... **A. blayana**

1* Pinnules glabrous. Flowers golden or pale yellow, 27–72 in each capitulum. Ovary glabrous

2 Capitula pale yellow, each composed of 27–49 flowers. Corolla c. 1.3 mm long. Calyx 0.5–1.0 mm long. Rhachis mostly with an orbicular gland only at the base of the uppermost pair of pinnae and with an orbicular petiolar gland usually at least 1 cm below the lowest pair of pinnae. Shrub or tree to 10 high. ..... **A. schinoides**

2* Capitula golden, each composed of 35–72 flowers. Corolla 2.0–2.4 mm long. Calyx 0.8–1.5 mm long. Rhachis with an orbicular or oblong gland at the base of the uppermost pair of pinnae only or sometimes also at the base of other pairs, the gland at the base of the lowest pair oblong. Shrub 1.0–2.5 m high or rarely a spindly tree to 5 m high.....**A. pruinosa**

A. schinoides Benth. occurs on the lower North Coast and the Central Coast of New South Wales usually in sandstone gullies near creeks in tall open forest (Tindale 1972), whereas *A. pruinosa* Cunn. ex Benth. is found on the Darling Downs District of south-eastern Queensland (Pedley 1979), as well as on the Northern Tablelands and North Western Slopes of New South Wales often amongst granite boulders. The latter species frequently occurs in eucalypt–*Callitris* forest on infertile sandy soil.

Boland & Midgley (1983) published a paper on *A. blayana* with notes on its distribution, ecology and wood as well as a short English description but did not validate the publication of this species with a Latin diagnosis or description.

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We wish to acknowledge grants from the Australian Biological Resources Study in 1989 and from the Royal Botanic Gardens Research Fund in 1990 to Mary Tindale for the research assistance. We thank the Director and staff of the Australian National Botanic Gardens, Canberra, for the loan of specimens to NSW, as well as assistance in various ways, especially by Miss E.M. Canning and Messrs I.R. Telford and G.F. Butler. Grateful acknowledgment is made to Professor T.C. Chambers, Director, Royal Botanic Gardens, Sydney, for providing funds for the plate of *A. blayana* prepared by Mrs Betty Maloney. Our thanks are due to Mr John Blay who discovered this species and made special collections of it at various times. Messrs D.J. Boland, E.G. Cole, B.V. Gunn and S.J. Midgley (CSIRO Division of Forest Research), Mr P. Cope, and Dr R. Outhred assisted by collecting specimens and gathering data. The Royal Australian Air Force assisted substantially in the collection of specimens by providing helicopter transport to otherwise almost inaccessible country during exercises in the Wadbilliga area. We are indebted to Dr L.A.S. Johnson for checking the Latin diagnosis prepared by Mary Tindale, to Miss S. Armitage who prepared Figure 2, to Mr P. Kodela and Miss Armitage for the word-processing of this manuscript, and to Mr D. Martens for some assistance with the preparation of the map.

References

Blay, J. (1987) *Trek through the Back Country* (Methuen Australia: North Ryde).

Boland, D.J., & S.J. Midgley (1983) *Acacia 'blayana' A.B. Court – a new Australian tree with a future?* Forest Genetic Resources Information No. 12: 21–23. (Food and Agriculture Organization of the United Nations).

Lee, A.T. (1948) The genus *Swainsona*. *Contr. New South Wales Natl. Herb.* 1: 131–271.

Pedley, L. (1979) A revision of *Acacia* Mill. in Queensland. *Austrobaileya* 1(3): 235–337.

Tindale, M.D. (1972) Group 8 (Bipinnate Acacias). Pp. 272–275 in N.C.W. Beadle, O.D. Evans & R.C. Carolin, *Flora of the Sydney Region*, edn 2 (Reed Books: Frenchs Forest).

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Acacia courtii, a new species from eastern New South Wales (*Acacia* sect. *Juliflorae*: Fabaceae)

Mary D. Tindale and Clare Herscovitch

Abstract

Tindale, Mary D. and Herscovitch, Clare (Royal Botanic Gardens, Sydney, N.S.W. 2000) 1990. Acacia courtii, *a new species from eastern New South Wales (*Acacia *sect.* Juliflorae*: Fabaceae). Telopea 4(1): 115–119.* A new species of *Acacia* with a restricted distribution on the North Coast of New South Wales is described, namely *A. courtii* (sect. *Juliflorae*). A map is provided showing its known distribution. This species is illustrated and its affinities discussed. A key is provided to this species and its ally *Acacia orites* Pedley.

Introduction

A new species of *Acacia* is described, prior to the forthcoming volume 2 of the Flora of New South Wales.

Taxonomy

The terminology of shapes in the specific description is that defined by Lee (1948: 144).

Acacia courtii *Tind. et Herscovitch*, **sp. nov.**

Acacia oritidi Pedley affinis, a qua differt calycibus 0.5–0.8 mm longis, corollis 1.8–2.3 mm longis, leguminibus crassis lignosisque, seminibus majoribus, 5.6–7.7 mm longis (arillo non incluso), 2.3–3.0 mm latis, nervis minoribus phyllodiorum dense anastomosantibus.

HOLOTYPUS: NEW SOUTH WALES: On roadside, Captain Cook Bicentenary Rd., North Brother Mtn., 27 km SW of Port Macquarie, in dry sclerophyll forest, rocky soil, altitude 40 m, small tree 7 m tall; fruit dark grey; associated with *Eucalyptus acmenoides, E. propinqua, E. intermedia*. 'Leaves' with red margins, somewhat glaucous and of weeping habit, *K.J. Phillis, for A.G. Floyd 1157*, 16.xi.1978 (NSW). Isotypi: BRI, CANB, K, Coffs Harbour (N.S.W.) Forestry Herbarium.

Tall shrub or weeping tree 7–20 m high; *trunk* d.b.h. to 50 cm; *foliage* pendulous, often tinged pink to purplish red in rapidly growing tips; *bark* smooth and grey, later black and furrowed. *Branchlets* slender, flexible, angled, becoming terete, pale tawny or pale green, glabrous, often slightly to moderately glaucous, bark sometimes slightly flaky in patches, becoming mottled then dark maroon-brown, often with fawn-brown lenticels. *Phyllodes* borne singly, green, dull, flattened, linear, (5–)11–18 cm long, 4.5–8.5(–12) mm wide, l/b = (10–)16–26(–33), widest at or near the middle, subcoriaceous, glabrous, tapered gradually towards apex and base; *nerves* prominent and pale with one main central nerve and on either side 1–3 longitudinal nerves which are slightly more or no more prominent than the longitudinal anastomosing minor nerves, the l/b of the areoles >10; *margins* red (when fresh), yellowish brown or light purplish brown (when dried); apical mucro attenuated, slightly oblique or hooked, to 1.2 mm long, bearing a minute orbicular gland; *basal gland of phyllode* solitary, adaxial, 0.5–0.7 mm

long, (0.1–)0.5–3.9 mm above the pulvinus, orbicular to ± oblong, the rim orange or yellow-tawny, glabrous, distinctly raised above the margin or ± sunken; *pulvinus* light tawny to reddish brown, glabrous, often glaucous in the furrows, 1.0–4.0 mm long, 1.0–3.0 mm wide. *Stipules* caducous, inconspicuous, c. 0.4 mm long, c. 0.3 mm wide at the base, deltate, orange-brown, scurfy. *Inflorescence* pale yellow, spicate, single or paired in the phyllode axils (rarely non-axillary), 3.0–6.5 cm long after anthesis, c. 5 mm wide; *flowers* 55–78, compactly arranged in bud, reduced to 25–44 flowers and becoming distant as the rhachis elongates, the flowers in clusters of 3 or 4 along the rhachis; *rhachis* and *peduncle* slender, tawny, glabrous, often slightly glaucous, longitudinally wrinkled when dried, probably terete when fresh, c. 0.6 mm diam.; *peduncle* 3–5 mm long; *bracts* apparently 2 per inflorescence, imbricate, papery, brown or brownish orange, narrow deltate with incurled margins, fimbriate but otherwise glabrous, 1.0–2.4 mm long; *bracteoles* (0.65–)0.7(–0.85) mm long, peltate or scutelliform, the claw (0.25–)0.4–0.5 mm long, comparatively wide, the margins densely fimbriate; lamina flat or angled inwards, 0.4–0.6 mm long, ± broad-ovate, membranous, the surface with spreading white hairs or more usually glabrous, the margin fimbriate with hyaline hairs c. 0.1 mm long. *Flowers* 4-merous, rounded in bud. *Calyx* pale, membranous, 0.5–0.8 mm long, 1.2–1.5 mm wide, dissected for 1/6–1/3 of its length into blunt, broadly deltate, glabrous lobes, often slightly keeled, the sinuses broadly obtuse, the margin fringed with minute white hairs, the tube covered with spreading white hairs 0.1–0.2 mm long. *Corolla* pale yellow to almost white, delicate, glabrous, 3–3.5 times the length of the calyx, 1.8–2.3 mm long, dissected for 1/2–3/5 of its length; *petals* elliptical, relatively broad, l/b = 2, mostly the margins slightly incurved towards the papillose apex. Stamens 3.0–4.8 mm long. *Ovary* sessile, ellipsoid or ± oblong, c. 0.8 mm long, c. 0.4 mm diam., pale yellowish orange, densely villous with white tapering hairs 0.25–0.3 mm long; *style* 3.0–3.3(–4.2) mm long. *Legumes* straight or falcate, linear, contracted slightly between the seeds, woody, thick, longitudinally wrinkled when dried, probably terete when fresh, (7.5–)12.5–18.0 cm long, (3.0–)3.5–4.0 mm wide, light brown to brown, glabrous, occasionally slightly glaucous; *margins* pale, shortly tapered to an acute apex and to the base; *stalk* c. 5 mm long, sparsely clothed with white, appressed hairs c. 0.2 mm long. *Seeds* (6–)8–11 per legume, elongated, ellipsoid and often laterally compressed, longitudinally placed in the legume, glossy, brown, with a lighter brown peripheral ridge, 5.6–7.7 mm long, 2.3–3.0 mm wide, 2.3–2.6 mm thick; *pleurogram* a thin dark line, narrowly U-shaped, open towards the hilum; *areole* elongated, 4.8–6.3 mm long, 1.3–1.6 mm wide; *funicle* golden orange when dried, filiform, lightly folded 4–8 times over the acentral basal aril. *Flowering*: November–January. *Fruiting:* November, legume probably taking about a year to mature (Figure 1).

DISTRIBUTION: NEW SOUTH WALES: Mid-north Coast: only known from North Brother Mtn, Camden Haven State Forest, and Middle Brother Mtn, Middle Brother State Forest (Figure 2).

HABITAT: Mostly occurring on dry, rocky, north-west- to west-facing mountain slopes in shallow soils, on microgranite, in mixed dry sclerophyll forest (White Mahogany and Grey Gum), at altitudes of 40–300 m.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Coast: Laurieton, Captain Cook Bicentenary Rd., near Camden Haven State Forest, 31°38′ S, 152°46′ E, *K.J. Phillis NSW 221504*, 26.i.1981 (NSW); Compartment 138, Middle Brother State Forest, 31°41′ S, 152°42′ E, wood voucher for phytochemical survey, *K.J. Phillis NSW 145771*, 25.i.1981 (AD, B, BM, CANB, CBG, K, L, MEL, MO, NSW, NE, PERTH, TL, UC, US); Devils Hole, Middle Brother Mountain, *A.G. Floyd 913*, 27.iv.1978 (NSW).

The specific epithet honours Mr Arthur B. Court who retired in January 1989 as

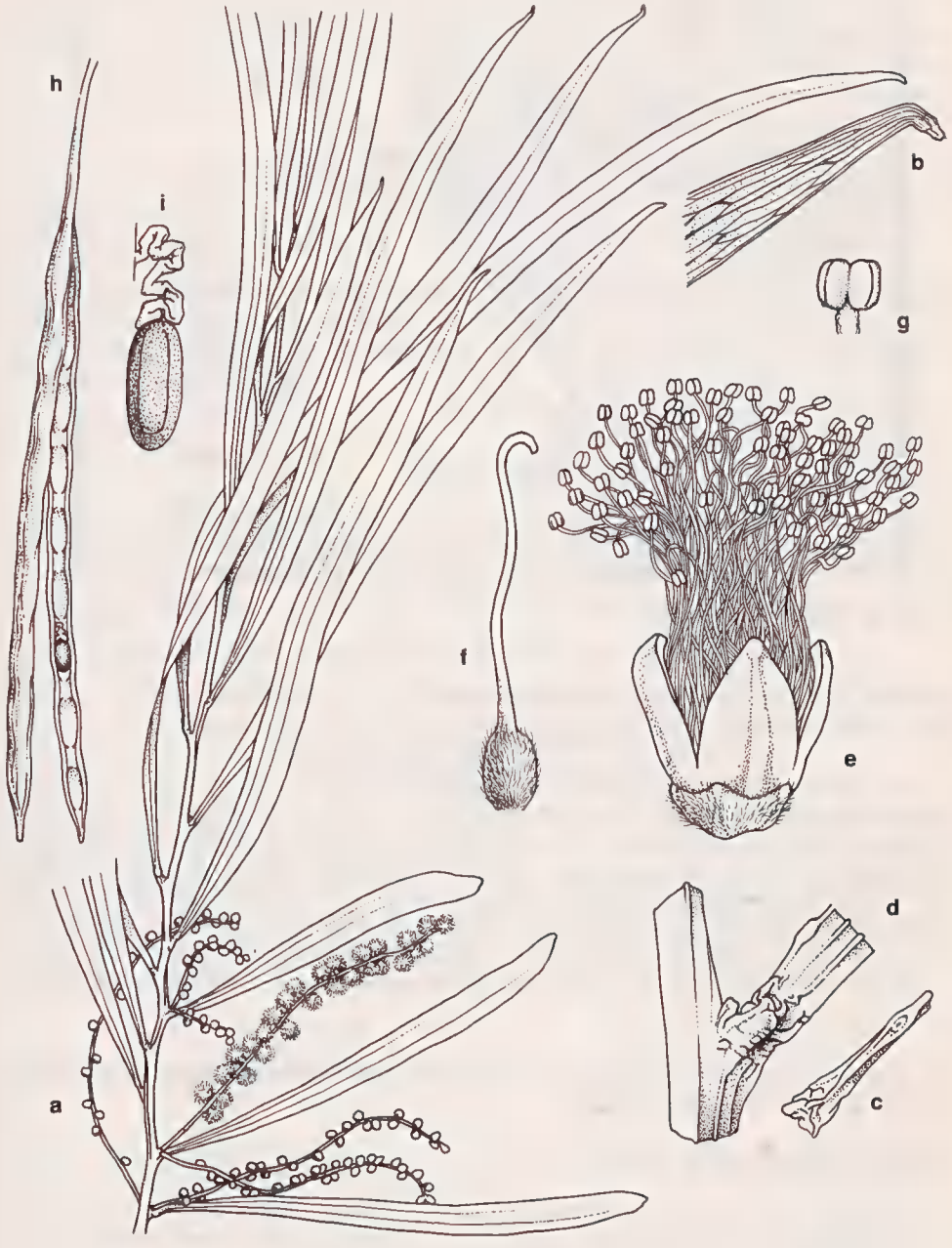

Figure 1. *Acacia courtii*. **a.** habit, with phyllodes and spicate inflorescences (x ⅔). **b.** apex of phyllode (x 4⅔). **c.** pulvinus, side view (x 4⅔). **d.** base of phyllode, with pulvinus and gland (x 4⅔). **e.** flower (x 13⅓). **f.** gynoecium (x 13⅓). **g.** anther (x 33⅓). **h.** legume (x ⅔). **i.** seed (x 2⅓). *Vouchers:* a-d, h-i, *K.J. Phillis NSW 145771;* e-g, *K.J. Phillis (AGF 1157).* Del. R.A. Roden.

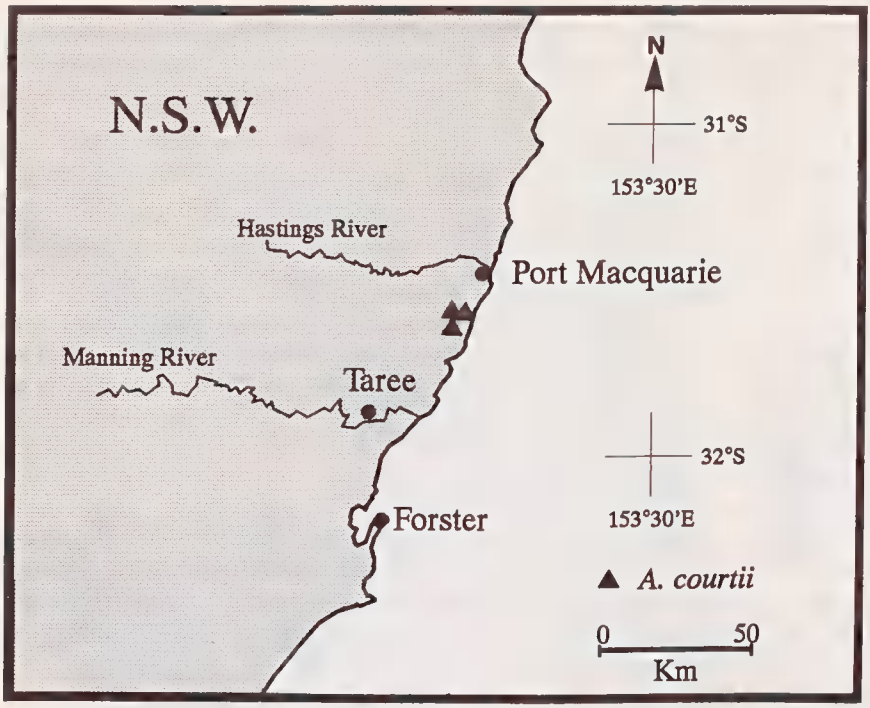

Figure 2. Distribution of *A. courtii*.

Assistant Director, Australian National Botanic Gardens, Canberra, A.C.T. He is revising the group of Australian *Acacia* species to which *A. courtii* belongs.

A. courtii is closely allied to *A. orites* Pedley (1964: 32–33, 1978: 167), both of which belong to sect. *Juliflorae* subseries *Tetramerae*. Most species of the latter subseries occur in eastern Australia. The flowers of the *Tetramerae* are 4-merous and the legumes (with one exception) elongated, narrow and ± constricted between the seeds. *A. courtii* has a very restricted distribution on Middle Brother and North Brother Mountains on the mid-North Coast of New South Wales, whereas *A. orites* is confined to the edge of rainforests and in wet sclerophyll forests with high rainfall at 600–900 m altitude on the Mount Warning shield volcano in far north-eastern New South Wales and south-eastern Queensland.

We would recommend a Conservation Code of 2V (vulnerable) according to the criteria used by Briggs and Leigh (1988).

Key to *A. courtii* and *A. orites*

1 Phyllodes with densely anastomosing nerves. Legumes thick, woody, 7.5–18.0 cm long. Seeds (not including the aril) 5.6–7.7 mm long, 2.3–3.0 mm wide. Calyces 0.5–0.8 mm long. Corollas 1.8–2.3 mm long. Flowering November-January ..... **A. courtii**

1* Phyllodes with sparsely anastomosing nerves. Legumes thinly coriaceous, 6.5–11.0 cm long. Seeds (not including the aril) 2.5–4.0 mm long, 1.7–2.0 mm wide. Calyces c. 0.5 mm long. Corollas 1.5–2.0 mm long. Flowering August-October ..... **A. orites**

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Our thanks are due to Dr R.W. Johnson, Director, Queensland Herbarium, for the loan of specimens of *A. orites*, as well as to Mr A.G. Floyd and Dr K.J. Phillis who drew our attention to *A. courtii*. Messrs. A.B. Court and A.G. Floyd also provided helpful suggestions regarding our manuscript.

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References

Briggs, J.D. & Leigh, J.H. (1988) Rare or Threatened Australian Plants. *Special Publication Australian National Parks and Wildlife Service* 14.

Lee, A.T. (1948) The genus *Swainsona*. *Contr. New South Wales Natl. Herb.* 1: 131–271.

Pedley, L. (1964) Notes on *Acacia*, chiefly from Queensland II. *Proc. Roy. Soc. Queensland* 75: 29–35.

Pedley, L. (1978) A revision of *Acacia* Mill. in Queensland. *Austrobaileya* 1: 75–234.

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Notes on *Boronia* (Rutaceae) in New South Wales, including descriptions of three new species

Peter H. Weston

Abstract

Weston, Peter H. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1990. Notes on Boronia *(Rutaceae) in New South Wales, including descriptions of three new species. Telopea 4(1): 121–128.* Three new species are described: *B. chartacea*, *B. umbellata*, and *B. warrumbunglensis*. I also discuss the taxonomic status of *B. whitei* and four taxa that had previously been given informal names.

In Jacobs and Pickard (1981) seven unnamed species of *Boronia* were listed for New South Wales as spp. A-G. In the course of preparing a treatment of *Boronia* for the forthcoming second volume of the Flora of New South Wales (Weston & Porteners in prep.), I concluded that at least three of these taxa, C, E and G, warranted formal recognition as species. In this paper these species are described and the systematics of the other unnamed taxa is discussed.

New species

All three of the new species described below belong to the informal '*B. ledifolia* group' of Weston, Carolin & Armstrong (1984). Below is a description that summarises the characters shared by all of the taxa in this group. Some preliminary comments on morphological terminology are necessary.

All taxa in the *B. ledifolia* group, as well as *B. lanceolata* and all taxa in the *B. bowmanii*, *B. grandisepala*, and *B. affinis* groups (see Weston et al. (1984: Appendix 1) for ostensive definitions of these groups) have the same, distinctive inflorescence structure (Figure 1). The inflorescences are exclusively axillary, subtended by foliage leaves. In the terminology of Briggs & Johnson (1979) the inflorescences are 2-nodate botryoids in which the second (i.e. non-basal) internode of the primary axis and the basal internodes of the secondary axes (if developed) are reduced to vestiges. All pherophylls are closely clustered together and when three or more flowers are developed, the inflorescence appears umbellate. In most species the prophylls of the primary axis have a minute lamina, and in some species, such as *B. warrumbunglensis*, these prophylls may be minutely compound.

Where hairs are present, their density is classified as sparse (only a few, scattered hairs), moderately dense (more than a few scattered hairs but not so dense that the underlying epidermis is obscured), or dense (obscuring the underlying epidermis).

Most species in the *B. ledifolia* group have adult leaves that are either glabrous or almost so (subgroup 1) or densely stellate-tomentose abaxially (subgroup 2). *B. mollis* is the only species of the *B. ledifolia* group native to eastern Australia that does not fall into either of these classes, having moderately stellate-tomentose abaxial leaflet surfaces. However, the seedling leaves and basal leaves in regenerating shoots are glabrous or almost so in all taxa for which I have seen appropriate material. In species of subgroup 2, there is an abrupt transition from the production of glabrous (or almost glabrous)

leaves to abaxially densely stellate-tomentose leaves. Nelson's direct method of character analysis (see Weston 1988) can be applied in this case: adult leaves with a glabrous or almost glabrous abaxial surface are more general than, and thus plesiomorphous relative to, adult leaves that are densely stellate-tomentose abaxially. Care must be taken to examine adult leaves when using this feature in identifying specimens.

The number in brackets that follows each heading of 'selected specimens' is the total number of specimens examined.

Boronia ledifolia group (Weston et al. 1984: 202–203)

Hairs mostly stellate. Inflorescence a 2-nodate botryoid (Figure 1), axillary; pherophylls persistent. Sepals valvate, persistent in mature fruit, shorter than the petals. Petals valvate, with the midvein prominently raised abaxially, persistent in mature fruit; tip straight, apical (neither incurved nor subterminal on the abaxial surface). Staminal filaments clavate, bearing the anthers apically, bearing stiff hairs on the abaxial surface and margins below the swollen tip, prominently glandular on the swollen tip, each gland usually bearing a minute stellate hair; antisepalous filaments longer than antipetalous. Anthers basifixed, monomorphic. Style attaching terminally on the ovary. Stigma rounded, not or scarcely wider than the style. Seeds black, dull due to the minutely colliculate surface of the testa.

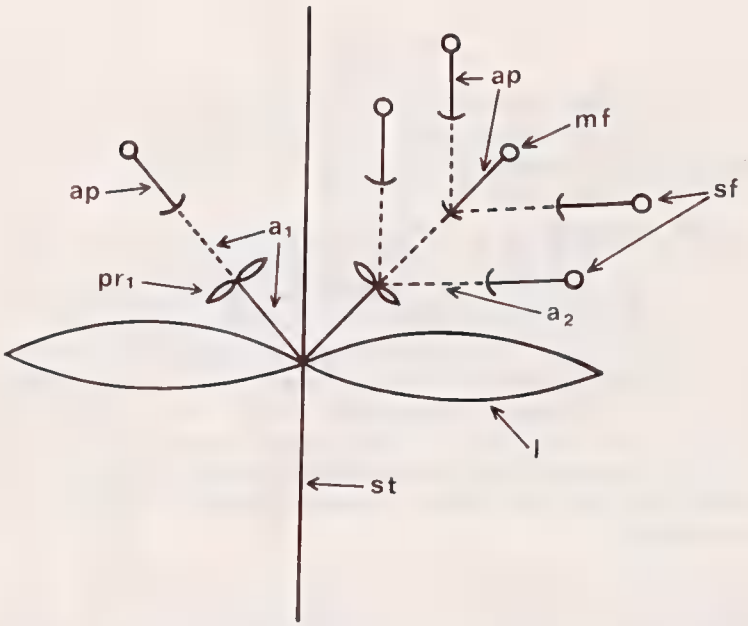

Figure 1. Diagramatic representation of inflorescence types in the *B. ledifolia* group. The inflorescence in the right-hand axil is typical of *B. umbellata*, while that in the left-hand axil is typical of *B. chartacea* and *B. warrumbunglensis*. Axes that do not elongate are represented by dotted lines. a_1, a_2 = primary and secondary axes respectively, ap = anthopodium, l = leaf, mf = median flower, pr_1 = prophylls of primary axis, sf = side flower, st = stem of leafy shoot.

Boronia chartacea *P. Weston*, **sp. nov.**

Ramuli stellato-tomentosi. Folia unifoliolata, chartacea; petiolus 1–2 mm longus; pagina adaxialis laminae prominenter glanduloso-verrucosa; pagina abaxialis laminae dense stellato-tomentosa; margines glanduloso-denticulati. Inflorescentiae axillares, 1(–3)-floribus. Petala valvata, rosea, costa abaxiali prominenter elevata, in statu maturo fructifero persistentia.

HOLOTYPE: NEW SOUTH WALES: North Coast: Newry State Forest, 1.9 km S of Urunga, 30°32′S 152°58′E, *R.G. Coveny 4603*, 13.9.1972 (NSW). ISOTYPES (n.v.): AD, BRI, CANB, CBG, K, MEL, PERTH.

[*B.* sp. C (aff. *rosmarinifolia*) in Jacobs & Pickard (1981: 191)]

Shrub, 0.4–2.7 m high. Branchlets moderately stellate-tomentose, terete to slightly angular, not obviously glandular. Leaves unifoliolate, chartaceous; petiole 1–2 mm long; lamina linear-elliptic to narrow-elliptic or narrow-oblong, acute to obtuse, 20–48 mm long, 2–5 mm wide, flat; adaxial surface prominently glandular-verrucose, glabrous or with a few scattered stellate hairs on the faintly impressed midvein; abaxial surface densely stellate-tomentose (and thus much paler than adaxial surface) except for the moderately stellate-tomentose, prominently protruding midvein; margins glandular-denticulate, recurved to revolute. Inflorescences 1(–3)-flowered; peduncle 0.5–1.5 mm long, densely stellate-tomentose; prophylls of primary axis minutely unifoliolose, 1.0–3.0 mm long, moderately stellate-tomentose. Anthopodia 4–8 mm long, moderately stellate-tomentose. Sepals ovate to broad-ovate, 2.0–3.5 mm long, 1.4–2.5 mm wide, densely and minutely pubescent near the margins but becoming glabrous towards the base adaxially, densely stellate-tomentose abaxially. Petals bright pink, 7–9 mm long, sparsely simple pubescent adaxially, moderately tomentose abaxially. Basal hairs of staminal filaments mostly simple. Anther appendage minute. Gynoecium glabrous. Cocci glabrous.

DERIVATION OF EPITHET: Latin *chartaceus*, papery, referring to the thin leaves, which are very brittle when dried.

FLOWERING PERIOD: August to October.

DISTRIBUTION AND HABITAT: In gullies and along creek lines, in wet sclerophyll forest, on sandstone or granitic substrates, at altitudes from 70 to 300 m, disjunctly distributed in the Wauchope, Urunga and Grafton areas of north-eastern New South Wales. Figure 2.

NOTES: *B. chartacea* most closely resembles *B. rosmarinifolia* and *B. ledifolia*. Both of these species are distinguished from *B. chartacea* by their tougher, not chartaceous leaves, which are not prominently glandular-verrucose and which have entire margins. *B. ledifolia* also differs in having unifoliolate to pinnate leaves, and *B. rosmarinifolia* differs in having sessile leaves. *B. chartacea* is sympatric with, but ecologically separated from, *B. rosmarinifolia* in the Grafton area, occurring in wet sclerophyll forest in gullies while *B. rosmarinifolia* occurs in dry sclerophyll forest on ridge-tops in this area.

SELECTED SPECIMENS (14): NEW SOUTH WALES: North Coast: Cabbage Tree Creek, Whiporie, *Benson 124 & Dodson*, 4.6.1984 (NSW); Whiteman Ck and Coaldale Rd, c. 20 miles NNW of Grafton, *Grieves s.n.*, 11.8.1969 (NSW); 'The Punchbowl", near Copmanhurst, *O'Grady s.n.*, 8.1970 (NSW); Bril Bril Ck, Bellangry State Forest, *Constable NSW 66836*, 15.10.1961 (NSW); Wilson R. above Wild Bull picnic area, 31°15′S 152°31′E, *Whaite 3680*, 24.8.1980 (NSW).

Boronia umbellata *P. Weston*, **sp. nov.**

Ramuli dense stellato-tomentosi. Folia 1–5-foliolata, chartacea; pagina adaxiali foliolorum fere glabra; pagina abaxiali foliolorum dense stellato-tomentosa; foliolum terminale plerumque anguste ellipticum, 25–58 mm longum, 6–16 mm latum.

Inflorescentiae axillares, 2–6-floribus. Anthopodia 6–16 mm longa. Sepala ovata, 3.0–3.5 mm longa, 1.6–2.0 mm lata. Petala valvata, rosea, costa abaxiali prominenter elevata, in statu maturo fructifero persistentia.

HOLOTYPE: NEW SOUTH WALES: North Coast: Sherwood Creek, 28 km NW of Coffs Harbour, 30°03'S 153°03'E, *H. Streimann 8124*, 11.10.1978 (CBG).

ISOTYPES: K, MEL, NSW, PERTH.

[*B.* sp. E (aff. *mollis*) in Jacobs & Pickard (1981: 191)]

Shrub, c. 1 m high. Branchlets densely stellate-tomentose, terete, not obviously glandular. Leaves mostly pinnate with 3–5 leaflets but unifoliolate at the 1–3 most basal nodes of an axillary shoot, chartaceous, glandular but not prominently so; petiole 8–17 mm long; rachis to 20 mm long, winged; leaflets entire, with recurved margins, with an obtuse to rounded tip, glabrous adaxially except for stellate hairs scattered along the impressed midvein, densely stellate-tomentose (and thus much paler) abaxially except for the moderately stellate-tomentose, prominently protruding midvein; terminal leaflet usually narrow-elliptical, 1.4–2.5 times as long as the lateral leaflets, 25–58 mm long,

Figure 2. Distributions of *B. chartacea* (square), *B. umbellata* (triangle), and *B. warrumbunglensis* (circle).

6–16 mm wide, usually less obtuse than lateral leaflets; lateral leaflets narrowly to broadly elliptical or sometimes spathulate or oblong, 15–35 mm long, 6–12 mm wide. Inflorescences sometimes paired in the axil, 2–6(–9)-flowered, sometimes with an accessory flower in the axils of some pherophylls; peduncle 0.5–11 mm long, densely stellate-tomentose; prophylls of primary axis minutely unifoliolose to cataphyllous, 1.0–4.0 mm long, densely stellate-tomentose or with indumentum similar to that of a foliage leaf. Anthopodia 6–16 mm long, moderately stellate-tomentose. Sepals ovate, 3.0–3.5 mm long, 1.6–2.0 mm wide, densely and minutely pubescent near the margins but becoming glabrous towards the base adaxially, moderately stellate-tomentose abaxially. Petals pink, 7–10 mm long, moderately simple-pubescent adaxially, moderately to densely stellate-tomentose abaxially. Basal hairs of staminal filaments mostly stellate. Anther appendage minute. Gynoecium glabrous. Cocci glabrous.

Derivation of Epithet: Latin *umbellatus*, like an umbrella, referring to the umbel-like inflorescences.

Flowering Period: August to October.

Distribution and Habitat: In sclerophyll forest on sandstone and metasediments, at altitudes from 100 to 600 m, restricted to the coastal ranges between Athol Glen and Coramba, north of Coffs Harbour, north-eastern New South Wales. Figure 2.

Notes: Cheel (1927) included specimens of *B. umbellata* within his concept of *B. rubiginosa* Cunn. ex Endl. This species, however, differs from *B. umbellata* in leaflet morphology (terminal leaflet 7–18 mm long, 3–6 mm wide, not more acute than lateral leaflets; lateral leaflets 4–14 mm long, 2–6 mm wide), and in having leaves with (1–)3–9 leaflets, lacking the transition from basal, unifoliolate leaves to trifoliolate or pinnate leaves in axillary shoots. *B. umbellata* superficially resembles *B. mollis*, which differs in having leaflets that are moderately stellate-tomentose abaxially, and sparsely stellate-tomentose adaxially, and in its narrow-triangular sepals. The shorter stellate hairs of *B. umbellata* give it a 'tidier', less shaggy tomentum than *B. mollis*. On average *B. umbellata* also has larger leaves with fewer leaflets than *B. mollis*. *B. umbellata* has also been confused with *B. keysii*, a species that is restricted to the Gympie area in south-east Queensland and that has virtually glabrous, 1–7-foliolate leaves with narrower leaflets than *B. umbellata*.

One specimen, *Burgess 282*, is labelled 'Pittwater, Sydney, 3/9/1973'. Almost certainly this specimen has been wrongly labelled. Burgess collected *B. umbellata* at Waihou trig on 25/8/1973 and it seems likely that *Burgess 282* was collected in the Coffs Harbour area and accidentally given the label of a specimen collected a few days later.

Selected Specimens (9): New South Wales: North Coast: Waihou trig, *Burgess 268*, 25.8.1973 (CBG, NSW); Wedding Bells State Forest, *Gray s.n.*, 8.9.1953 (NSW); Nana Glen, *Shiress s.n.*, 9.1924 (NSW); 15 km from Moonee Creek turn off to Lower Bucca, *Steley s.n.*, 12.1974 (BRI, NSW); Mt Coramba, *Boorman s.n.*, 11.1912 (NSW).

Boronia warrumbunglensis *P. Weston*, **sp. nov.**

Ramuli stellato-tomentosi. Folia pinnata, 3–7-foliolata, firma, glabra vel fere glabra; petiolus 1.5–7 mm longus; foliola 4–16 mm longa, 1.0–3.0 mm lata, anguste oblonga, obtusa. Inflorescentiae axillares, 1–2-floribus; pedunculus 0.5–1.0 mm longus. Petala valvata, rosea, costa abaxiali prominenter elevata, in statu maturo fructifero persistentia.

Holotype: New South Wales: North Western Slopes: Oxley Hwy, c. 10 km S of Coonabarabran, 31°23'S 149°15'E, *M.G. Corrick 5883*, 9.9.1977 (NSW).

Isotype (n.v.): MEL.

[*B.* sp. G (aff. *granitica*) in Jacobs & Pickard (1981: 191)]

Shrub, 0.3–1 m high. Branchlets moderately stellate-tomentose, terete, not obviously glandular. Leaves pinnate with 3–7 leaflets, firm, glandular-punctate; petiole 1.5–7 mm long, rachis 2–12 mm long, winged; leaflets entire, glabrous or rarely very sparsely stellate-hairy, 4–16 mm long, 1.0–3.0 mm wide, narrow-oblong, obtuse, slightly paler below; margins recurved; terminal leaflet 1–2 times longer than lateral leaflets. Inflorescences 1–2-flowered; peduncle 0.5–1.0 mm long, densely stellate-tomentose; prophylls of primary axis cataphyllous to minutely unifoliolose to trifoliolose, 1.0–2.5 mm long, densely stellate-tomentose. Anthopodia 3–7 mm long, densely stellate-tomentose. Sepals ovate, 3.0–3.5 mm long, 1.6–2.0 mm wide, densely and minutely pubescent near the margins but becoming glabrous towards the base adaxially, densely tomentose abaxially. Petals pink, 5–7 mm long, moderately pubescent adaxially, moderately to densely tomentose abaxially. Basal hairs of staminal filaments simple or stellate. Anther appendage minute. Gynoecium glabrous. Cocci sparsely to moderately covered with stiff, simple to stellate hairs.

Derivation of Epithet: Refers to its restricted occurrence in the Warrumbungle Mountains and nearby areas.

Flowering Period: August to October.

Distribution and Habitat: In dry sclerophyll forest on sandstone, at altitudes between 500 and 600 m, restricted to the Warrumbungle Mountains — Coonabarabran district. Figure 2.

Notes: *B. warrumbunglensis* most closely resembles *B. ruppii*, *B. glabra* and *B. granitica*. *B. glabra* differs from *B. warrumbunglensis* in its consistently unifoliolate, sessile leaves. *B. ruppii* differs in its narrowly to broadly elliptical to spathulate leaflets and in its longer peduncles (2–15 mm long). *B. granitica* differs in its young leaves and branchlets being moderately hirsute with long white hairs.

B. warrumbunglensis and *B. glabra* are broadly sympatric but no specimens intermediate between them have been collected.

Selected Specimens (21): New South Wales: North Western Slopes: Rocky Glen, *Boorman s.n.*, 9.1908 (NSW); Coonabarabran — Narrabri road, *McMair N/04, N/07*, 20.8.1976 (NSW); ridge near Mt Wheoh, *Harden 15*, 8.1975 (NSW); Timor Rock, *Harden 16–17*, 8.1975 (NSW); Siding Spring, *Overall NSW 122243*, 17.9.1967 (NSW); Warrumbungle Ra, 19 km WSW of Coonabarabran, 2.0 km E of Burrumbuckle Rock, 31°20'S 149°05'E, *Crisp 4355*, 10.10.1978 (CBG, NSW).

Notes on some formal and informal taxa listed for New South Wales in Jacobs & Pickard (1981)

B. whitei *Cheel*

In describing *B. whitei*, Cheel compared it with *B. alulata* and *B. granitica*, but did not discuss the morphological distinction between it and *B. ledifolia*, other than remarking that 'It is quite distinct from *B. denticulata*, *B. rubiginosa* and *B. triphylla* [= *B. ledifolia*]' (Cheel 1927: 406). However, he described the leaves of *B. whitei* as 'pinnate, 5–9 leaflets' (Cheel 1927: 405) and presumably regarded *B. ledifolia* and *B. triphylla* as consistently unifoliolate and trifoliolate, respectively. The geographic distribution was reported as Tent Hill, New England, Emmaville, Torrington, and Bismuth.

Since 1927 a number of specimens have been collected that have blurred the distinction between *B. ledifolia* and *B. whitei*. Firstly, some specimens from the Torrington area are trifoliolate, but in all other respects they resemble other specimens of *B. whitei*.

Secondly, a number of pinnate-leaved specimens, that seem morphologically indistinguishable from typical *B. whitei*, have been collected from the Putty Road and nearby areas on sandstone between the Hunter Valley and Colo. The populations from which these specimens were sampled apparently intergrade with typical *B. ledifolia* in the area between Kulnura and Maroota. This situation is complicated by the fact that plants of *B. ledifolia* often show an ontogenetic transition from pinnate juvenile leaves to trifoliolate or unifoliolate adult leaves. Since it is impossible to distinguish *B. whitei* from *B. ledifolia* using available morphological evidence, Weston and Porteners (in prep.) have treated the former name as a synonym of the latter.

'**Boronia** sp. A'

This informal name was used to designate specimens from the Fitzroy Falls — Belmore Falls and Nerriga areas, which seemed to differ from *B. deanei* in their longer, more acute, flatter leaves and larger flowers. Prior to Jacobs & Pickard (1981), very few collections of *B. deanei* had been made and it was thought to be restricted to the Clarence–Wolgan area and Kanangra-Boyd plateau. In 1981, D.H. Benson and H. Bryant re-collected *B. deanei* extensively in the Clarence area, and these specimens, together with a more recent collection from Nalbaugh National Park, near Eden, seem to 'blur' the distinction between *B. deanei* and *B.* sp. A. In particular, there is an ontogenetic transition in *B. deanei* from longer, flatter, acute leaves to shorter almost terete, obtuse leaves. Also, there is some overlap in flower dimensions between the two samples. Consequently, Weston and Porteners (in prep.) have treated them as synonymous. Nevertheless, specimens referred to *B.* sp. A differ in overall appearance from *B. deanei* and they may well be morphometrically separable.

'**Boronia** sp. B (aff. **rosmarinifolia**)'

When 'Plants of New South Wales' (Jacobs & Pickard 1981) was published, this taxon was represented by a single fruiting collection at NSW (Burbong near Gilgandra, *McReaddie NSW 122247*, 3.12.1960). This specimen differs from *B. glabra*, the other species of the *B. ledifolia* group present in this area, in having leaves that are densely tomentose abaxially. *McReaddie NSW 122247* has moderately hairy cocci and thus differs from *B. rosmarinifolia*, a coastal species with glabrous cocci. Since 1981, a flowering specimen, possibly belonging to the same taxon as McReaddie's specimen, has been collected (Pilliga Scrub, Forest Way, c. 25 km W from Newell Hwy, 30°38'S 149°24'E, *Walsh 1336*, 14.8.1984 (CANB, MEL, NSW)). Since these specimens are very similar to, but do not match, *B. glabra* and *B. rosmarinifolia*, it seems reasonable to assign them tentatively to an unnamed species. However, it is premature to recognise this taxon formally without sampling it more adequately.

'**Boronia** sp. D (aff. **rubiginosa**)'

This informal name was used for a large-flowered population from the Nandewar Ranges which, for characters other than flower size, matches *B. rubiginosa*. The latter is a patchily distributed species that shows geographic variation in other characters such as leaflet number, and it seems reasonable to regard the Nandewar population as an allopatric variant, rather than as a separate taxon. The taxonomic status of *B. rubiginosa* is unclear in some respects. It seems to be parapatric with *B. ledifolia* and these taxa may intergrade in the upper Hunter River valley. However, Cheel's (1927) inclusion of specimens from Cowan Creek, Berowra and Hawkesbury River within *B. rubiginosa* was mistaken: these are juvenile, pinnate-leaved specimens of *B. ledifolia*.

'**Boronia** sp. F (aff. **ruppii**)'

B. ruppii is patchily distributed, with populations in the Barraba, Merriwa and Berrima areas, and near the Colo and lower Nepean Rivers from Glen Davis to Kenthurst. The

geographically isolated populations differ from one another, particularly in the density of stellate hairs on the abaxial surfaces of the sepals and petals. For example, in the specimens from near Glen Davis and Berrima the abaxial surface of the sepals is glabrous and that of the petals sparsely stellate-tomentose, while in specimens from the Barraba area they are densely stellate-tomentose. These extreme variants are linked by morphologically intermediate populations from other localities. *B.* sp. F represents a morphologically undefined, apparently random sample of specimens of *B. ruppii*.

Acknowledgements

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References

Briggs, B.G. & Johnson, L.A.S. (1979) Evolution in the Myrtaceae — evidence from inflorescence structure. *Proc. Linn. Soc. New South Wales* 102: 157–256.

Cheel, E. (1927) Descriptions of four new species of *Boronia* with notes on certain other species. *J. & Proc. Roy. Soc. New South Wales* 61: 401–414.

Jacobs, S.W.L. & Pickard, J. (1981) *Plants of New South Wales* (Govt Printer: Sydney).

Weston, P.H. (1988) Indirect and direct methods in systematics. Pp. 27–56 in Humphries, C.J. (ed.), *Ontogeny and Systematics* (Columbia Univ. Press: New York).

Weston, P.H., Carolin, R.C. & Armstrong, J.A. (1984) A cladistic analysis of *Boronia* Sm. and *Boronella* Baill. (Rutaceae). *Aust. J. Bot.* 32: 187–203.

Weston, P.H. & Porteners, M. (in prep.) *Boronia*. In Harden, G. (ed.) *Flora of New South Wales*.

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Nablonium is a congener of *Ammobium* (Asteraceae–Gnaphalieae)

Arne A. Anderberg

Abstract

Anderberg, Arne A. (Swedish Museum of Natural History, Department of Phanerogamic Botany, P.O. Box 50007, S-104 05 Stockholm, Sweden) 1990. Nablonium *is a congener of* Ammobium *(Asteraceae-Gnaphalieae). Telopea 4(1):129–135.* The monotypic genus *Nablonium* Cass. is demonstrated to be a taxon with its closest extant relative within the genus *Ammobium* R.Br. Thus, *N. calyceroides* is transferred to the latter genus, and the new combination *Ammobium calyceroides* (Cass.) A. Anderb. is made. The phytogeography and systematic position of the genus is briefly discussed.

Introduction

The genus *Ammobium* R.Br., or at least one of its species, viz. *A. alatum* R.Br., is well known to everyone familiar with Australian Asteraceae, but also to horticulturists who know of it as the 'winged everlasting'. *Ammobium alatum* is not uncommon in dry forests and on forest edges in north-eastern New South Wales and south-eastern Queensland. In Tasmania and South Australia it occurs only as a garden escape (Curtis 1963, Cooke 1986). Reaching one metre in height and having distinctly winged stems, showy white involucral bracts and yellow florets, this is a conspicuous plant which easily attracts attention in the field. The second species of the genus, *A. craspedioides*, is confined to meadows and forest edges near Yass (N.S.W.). At first glance it has an extraordinary superficial similarity to a much more common taxon of another genus, i.e. *Craspedia glauca*. Due to apparent similarity it is possible to *A. craspedioides* has been overlooked, but I suspect it to be a very rare and possibly endangered species. During my Australian field trip with B. Nordenstam towards the end of 1989, I was fortunate enough to find not only *A. alatum* but also the rare *A. craspedioides* in the field.

The monotypic genus *Nablonium* Cass., confined to Tasmania and to the islands of Bass Strait, is a 5 cm high, stoloniferous perennial which has long been a taxonomic problem, because of its aberrant morphology.

In the present paper it is argued that the three superficially dissimilar plants mentioned above have common ancestry and form a monophyletic group. The reasons are presented below.

Earlier work

The systematic position of *Ammobium* has never been controversial. Brown (1824) indicated that the genus belonged to the same tribe as *Gnaphalium* L., which is still a valid statement (i.e. the Gnaphalieae sensu Anderberg 1989). Merxmüller et al. (1977) included *Ammobium* in what they called the *'Helichrysum* group' of the Inuleae–Gnaphaliinae. Orchard (1981), discussing *Ixodia, Cassinia, Ozothamnus* and other genera, stated that *Ammobium* was probably a relative of this generic group.

Nablonium Cass., originally placed in the tribe Anthemideae by Cassini (1825) due to

some alleged similarity with *Cotula* and other genera of that tribe, was later (Bentham 1867) placed in the tribe Heliantheae. Still later, Bentham (1873) changed its position from the Heliantheae to the Inuleae. Hoffmann (1890), following Bentham (1873), placed *Nablonium* in the Inuleae–Buphthalmineae, a group comprising various genera with paleate receptacles, which are today considered to belong to several different tribes.

Leins (1971) investigated the pollen ultrastructure of the Inuleae–Inulinae and the Inuleae–Buphthalminae. Because of Hoffmann's circumscription of the Inuleae–Buphthalminae, *Nablonium* was also investigated in this context. The pollen of virtually all investigated taxa had only one sexine layer, whereas pollen of *N. calyceroides* was completely different. With a double sexine having a perforated inner layer, the pollen morphology of *Nablonium* approached the pollen structures described for members of the Inuleae–Gnaphaliinae, Inuleae–Angianthiinae, and the Inuleae–Anthrixiinae (Besold 1971). Leins concluded that *Nablonium* was misplaced in the Inuleae–Buphthalminae, advocating its transfer to the subtribe Angianthiinae. The only obstacle would, according to Leins, be the fact that the members of the Angianthiinae are all provided with secondary capitula. Hence, Leins hypothesized the paleate capitula of *Nablonium* to be an extremely reduced cluster of capitula, homologous to the secondary heads of the other Angianthiinae. He also interpreted the protruding spines and broad cypsela in *Nablonium* as resulting from a fusion between the cypsela itself with two surrounding involucral bracts found in many taxa of that subtribe. Merxmüller et al. (1977) accepted Lein's conjecture and placed *Nablonium* in the *Angianthus* group of the Inuleae–Gnaphaliinae s. lat.

The systematic position

In my analysis of the phylogeny of the Gnaphalieae (Anderberg in press), *Nablonium* was omitted as being very derived, or even misplaced in the tribe (cf. Anderberg 1989). The extent of autapomorphic character states encountered in *Nablonium* made it difficult to compare with other taxa. Leins' conclusion that *Nablonium* was a derived relative of *Angianthus* and the other genera of the Angianthiinae s. str. could not be corroborated in my investigation. The closest relative of *Nablonium* was to be found elsewhere.

I had little suspected that *Ammobium alatum* and *Nablonium calyceroides* could be closely related, until I investigated material of the second species of *Ammobium*, the rare *A. craspedioides*. This species proved to be almost intermediate between the other two, sharing some character states with *A. alatum* and others with *N. calyceroides*. In my analysis of the phylogeny of the tribe, *Ammobium* was included among the taxa of the Cassiniinae, and found to be a distant relative of the *Cassinia* clade itself.

The characters

1. Both species of *Ammobium* as well as *Nablonium calyceroides* are perennial herbs. The outgroup like most other genera of the *Cassinia* generic group are shrubs.

(0) *Frutescent.*

(1) *Herbaceous.*

2. The frutescent taxa of the outgroup are all much branched. *A. alatum* has an almost unbranched main stem but still a few branches in the synflorescence. *A. craspedioides* and *Nablonium* are completely unbranched.

(0) *Stems branched, at least apically.*

(1) *Stems unbranched.*

3. The lower surface of the leaves are clad with whitish tomentum in all taxa. The leaves are strongly decurrent in *A. alatum*, forming broad stem wings. In *A. craspedioides* the cauline leaves are somewhat decurrent basally, something which cannot be detected in *Nablonium*. The outgroup includes taxa with or without decurrent leaves and has consequently been coded with a question-mark in the matrix.

(0) *Leaves at least somewhat decurrent.*

(1) *Leaves not decurrent.*

4. The leaves in all taxa form a basal rosette. In *Nablonium* and in *A. craspedioides* the short stem makes the basal leaf rosette very prominent, but in *A. alatum* it is less conspicuous. The frutescent taxa of the related genera lack basal leaf rosettes.

(0) *Leaf rosette absent.*

(1) *Leaf rosette present.*

5. The capitula are solitary in *Nablonium* and in *A. craspedioides*, but in *A. alatum* they are situated a few together in loose corymbs. In the outgroup and in most of the related genera the capitula are numerous and densely clustered.

(0) *Capitula many together, clustered.*

(1) *Capitula few together, in loose corymbs.*

(2) *Capitula solitary.*

6. The involucral bracts are tawny and transparent in both *Nablonium* and *A. craspedioides*, whereas the bracts in *A. alatum* are white and opaque. In the outgroup most taxa have white, opaque bracts, but tawny, transparent bracts are found also in some taxa. Hence, this character has been coded with a question-mark in the outgroup.

(0) *Involucral bracts white, opaque.*

(1) *Bracts tawny, more or less transparent.*

7. The paleae are apically entire in *Cassinia* and in the other paleate taxa of the group. Generally they are similar to the innermost bracts. Lacerate paleae are found in *A. craspedioides* and in *Nablonium*.

(0) *Paleae entire.*

(1) *Paleae lacerate.*

8. The colour of the hermaphroditic disc-florets is bright yellow in both species of *Ammobium*, but white in *Nablonium* which, however, has pale yellowish buds. The same condition can be observed in *Cassinia* and *Ozothamnus* R. Br., as well as in the related and likewise white-flowered genus *Ixodia* R. Br. The outgroup has been coded with a question-mark since some species are yellow-flowered and others are white-flowered.

(0) *Florets yellow.*

(1) *Florets white.*

9. The cypselas are glabrous and dorsiventrally more or less flattened in all three taxa. In *A. alatum* the cypsela is elongated with parallel margins, but in the other two it is stout with margins converging towards the carpopodium. The cypselas of the outgroup are small and more or less elongated.

(0) *Cypselas elongated.*

(1) *Cypselas stout.*

10. Pappus bristles are missing, but the cypselas are provided with two apical spines derived from the apical portion of the cypsela wall. The cypselas of *A. alatum* have an apical cup-shaped outgrowth from the cypsela wall, laterally furnished with two short subulate teeth. In *A. craspedioides*, the apical cup is even more prominent and the two lateral teeth are larger and very protruding, looking more like lateral spines. The spines reach an even more impressive development in *Nablonium*, in which the cup-shaped apical portion has become an integral part of the widened apical portion of the cypsela. This is a most striking transformation series that becomes obvious when the cypselas of the three taxa are compared (Figure 1).

(0) *Cypselas without spines.*

(1) *Cypselas with short spines.*

(2) *Cypselas with moderate spines.*

(3) *Cypselas with long spines.*

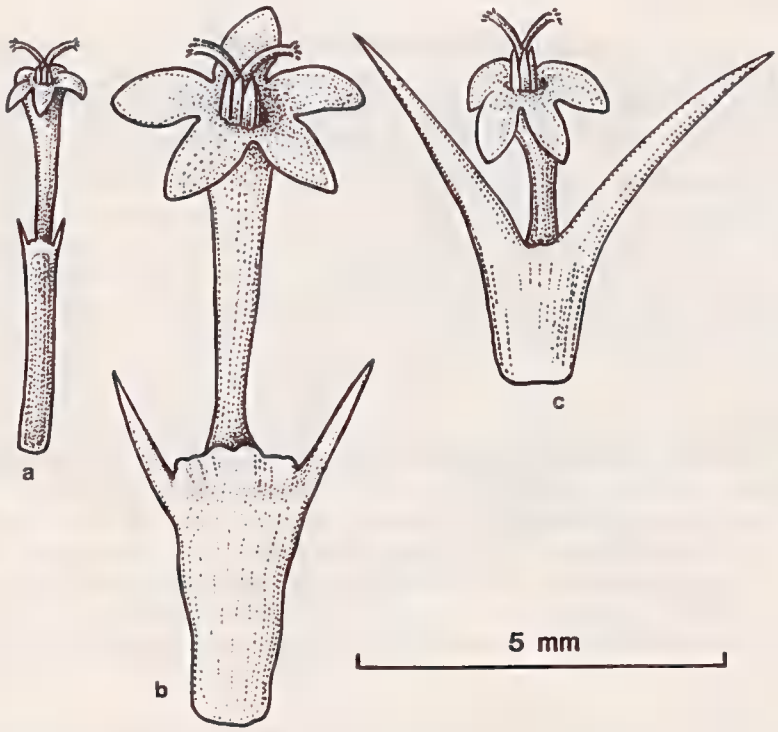

Figure 1. Cypsela and floret. **a.** *Ammobium alatum*. **b.** *A. craspedioides*. **c.** *A. calyceroides* a. *Anderberg & Anderberg 7148* (S). b. *Nordenstam & Anderberg 743* (S). c. *Comber 2135* (K).

Table 1. Data matrix. The numbers correspond to the numbers in the text and in the cladogram in figure 2.

	0000000001 1234567890
Cassinia	00?00?0?00
A. alatum	1001100001
A. craspedioides	1101211012
A. calyceroides	1111211113

Cladistic analysis

In order to elucidate the phylogeny of *Ammobium alatum*. *A. craspedioides*, and *Nablonium calyceroides*, a character data matrix (Table 1) was analysed with the computerised parsimony program Hennig86 (Farris 1988). The likewise paleate, and closely related, genus *Cassinia* was used as outgroup to analyse the interrelationships between the three taxa. The cypsela spine character (character 2) was coded as an additive transformation series, and using the option ie (implicit enumeration) only one cladogram was obtained. This cladogram was 13 steps long with a consistency index (ci) of 1 and retention index (ri) of 1.

The most parsimonious solution to the character distribution indicates that *Ammobium craspedioides* and *Nablonium calyceroides* are sister taxa, evolved from a common ancestor. The sister taxon of this species pair is *A. alatum*. No character was found to indicate

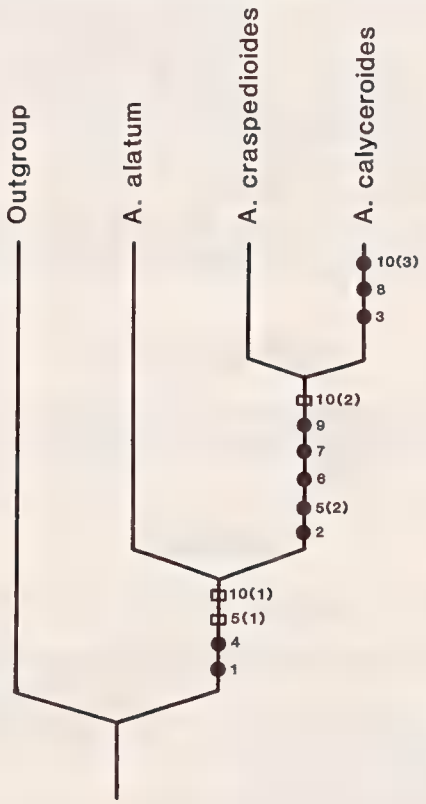

Figure 2. Cladogram of the genus *Ammobium*. Black dots are synapomorphies, open squares are synapomorphies transforming on the cladogram.

that *A. alatum* and *A. craspedioides* form a monophyletic group. *Ammobium* is obviously paraphyletic as it stands, since *A. craspedioides* and *Nablonium* form a monophyletic group diagnosed by 6 synapomorphies.

Three solutions are available in order to have the taxonomy reflect the phylogeny of the group. *Ammobium* becomes monophyletic if *Nablonium* is included. It becomes monophyletic also if *A. craspedioides* is transferred to *Nablonium*, or if *A. craspedioides* is placed in a new monotypic genus since *Ammobium* will then become monotypic.

Since the three taxa together represent an evident group which would be concealed if they were to be kept as separate genera, I have chosen to include *Nablonium calyceroides* in *Ammobium*. The following new combination is thus necessary:

Ammobium calyceroides *(Cass.) A. Anderb.* **comb. nov.**

BASIONYM: *Nablonium calyceroides* Cassini, Dictionnaire des sciences naturelles 34: 101 (1825).

Phytogeography

The distribution of the three species of *Ammobium* shows a vicariance pattern that is of interest. *A. alatum*, the sister group of the other two species, has a distribution in north-eastern N.S.W. and south-eastern Queensland, whereas *A. craspedioides* and *A. calyceroides* are distributed more to the south, *A. craspedioides* occurring in N.S.W., just north of the A.C.T., and *A. calyceroides* in Tasmania and adjacent islands. The ancestral populations of the three taxa can be hypothesized to have undergone a successive splitting. First a north-eastern population, later evolving into *A. alatum*, was separated from a southern population (the ancestor of *A. craspedioides* and *A. calyceroides*). This southern population was later split in a continental population (*A. craspedioides*) and a Tasmanian population (*A. calyceroides*).

Tasmanian–mainland vicariance patterns are found also in other genera of flowering plants. In the Gnaphalieae the genus *Ewartia* Beauverd has a similar distribution.

Acknowledgements

I would like to express my gratitude to my Australian colleagues for all their assistance during my field trip in Australia September to December 1989.

References

Anderberg, A.A. (1989) Phylogeny and reclassification of the tribe Inuleae (Asteraceae). *Canad. J. Bot.* 67: 2277–2296.

Anderberg, A.A. (in press) Phylogeny and taxonomy of the tribe Gnaphalieae (Asteraceae). *Opera Bot.*

Bentham, G. (1867) *Flora Australiensis* vol. 3 pp. 583–584. (Lovell Reeve & Co: London).

Bentham, G. (1873) Compositae. In Bentham, G. & Hooker, J.D., *Genera plantarum* vol. 2 pp. 163–533 (Lovell Reeve & Co: London).

Besold, B. (1971) Pollenmorphologische Untersuchungen an Inuleen (Angianthinae, Relhaninae, Arthrixiinae). *Diss. Bot.* 14. Lehre.

Brown, R. (1824) *Ammobium alatum*. In Sims, J. (ed.) *Curtis's Bot. Mag.* vol. 51 (9), t. 2459 (Sherwood, Jones & Co: London).

Cassini, H. (1825) Nablonion. In Cuvier, G. (ed.) *Dictionnaire des sciences naturelles* vol. 34, pp. 101–103 (Le Normant: Paris).

Cooke, D.A. (1986) *Ammobium*. In Jessop, J.P. & Toelken, H.R. *Flora of South Australia* vol. 3, p. 1495 (S.A. Govt Printing Div.: Adelaide).

Curtis, W.M. (1963) *The student's flora of Tasmania* vol. 2, p. 343 (Govt Printer: Tasmania).

Farris, J.S. (1988) *Hennig 86, version 1.5., users reference*. (Published by the author: New York).

Hoffmann, O. (1890) Compositae-Inuleae. In Engler, A. & Prantl, K. (Eds.) *Die natürlichen Pfanzenfamilien* vol. 4, pp. 172–210 (Engelmann: Leibzig).

Leins, P. (1971) Pollensystematische Studien an Inuleen 1. Tarchonanthinae, Plucheinae, Inulinae, Buphthalminae. *Bot Jahrb. Syst.* 91 (1): 91–146.

Merxmüller, H., Leins, P., & Roessler, H. (1977) Inuleae–systematic review. In Heywood, V.H., Harborne, J.B., & Turner, B.L. (eds.), *The Biology and Chemistry of the Compositae* vol. 1, pp. 577–602 (Academic Press: London).

Orchard, A.E. (1981) The generic limits of *Ixodia* R. Br. ex Ait. (Compositae–Inuleae). *Brunonia* 4: 185–197.

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SHORT COMMUNICATION

Halgania brachyrhyncha (Boraginaceae), a new species from eastern Australia

During preparation of a treatment of the Boraginaceae for the Flora of New South Wales, it became apparent that the species that had long been known as *H. preissiana* in N.S.W. was quite distinct from that taxon. This species, described below as *Halgania brachyrhyncha*, is known from relatively few specimens collected in scattered areas ranging from the Taroom district in southern Queensland to near Nowra on the South Coast of N.S.W. It appears to be most closely related to *H. preissiana*.

Halgania brachyrhyncha *Peter G. Wilson*, **sp. nov.**

H. preissianae similis sed habitu procumbenti, indumento longiore et magis patenti, dentibus folii plerumque plus numerosis, appendice antherae brevissima differt.

HOLOTYPE: NEW SOUTH WALES: Central Western Slopes: Murrumbo Gap, 49 km W of Denman, *H. Streimann 820*, 15.12.1973 (NSW). ISOTYPES (not seen): A, BRI, CBG, K, L.

Semi-prostrate to spreading perennial shrub 0.3–0.8 m high; *hairs* 2-armed, somewhat spreading. *Leaves* variable, elliptical to oblanceolate, 0.6–4.5(–6) cm long, 0.3–2 cm wide, scabrous, coarsely dentate, tapering rather abruptly towards the base. *Inflorescences* terminal, made up of 1 or more monochasial cymes, each of which is composed predominantly of 2-flowered units. *Flowers* 5-merous, rarely 6- or 7-merous; *corolla* deep blue, 7.5–8 mm in diameter; *pedicel* 4–10 mm long, becoming recurved at fruiting; *calyx* 3.5–4.5 mm long (4–5.5 mm long at fruiting), connate at the base, *lobes* 1.5–3.5 mm long, ± equal; *petals* 3.5–6 mm long, 2–3 mm wide, fused for c. 1 mm at the base, glabrous except for a line of hairs down the abaxial surface, *apex* acute to rounded; *stamens* with free filaments 0.5–0.6 mm long, *anthers* 1.8–2.3 mm long, projecting from the flower as an erect column around the style, hairy; *anther appendage* inconspicuous, 0.2–0.3 mm long; *ovary* conical; style terminal, 2–2.4 mm long. *Fruit* a drupe, ± ellipsoidal, 3.5–5 mm long, 1.5–2.2 mm wide; 1–2-seeded.

SELECTED SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: The Sheepwalk, Burragorang Valley, *L. Johnson & A. Rodd 438*, 26.2.1967 (NSW). South Coast: 12 miles [c. 19 km] SW of Nowra, *F.A. Rodway*, 23.1.1949 (NSW). Central Western Slopes: Mt Arthur Reserve, Wellington, *G. Harden*, 27.11.1978 (NSW); Apex Lookout, Denman, *G. D'Aubert 433, P. Hind & C. Jones*, 6.12.1988 (NSW); Wollar–Sandy Hollow, *E.F. Constable*, 16.9.1948 (NSW 7691). QUEENSLAND: Leichhardt District: between Cracow and Wandoan, *D.M. Gordon 725*, — (BRI). Darling Downs: Pongi, 6 miles [c. 10 km] NW of Glenmorgan, *R.W. Johnson 630*, 9.9.1958 (BRI).

HABITAT: An uncommon species found on rocky sites, particularly ridges or hillsides, on sandstone or conglomerate. Collectors' notes record various vegetation types ranging from tall shrubland to woodland and open forest.

FLOWERING PERIOD: September to February.

AFFINITIES: This species appears to be most closely related to *Halgania preissiana*, a Western Australian endemic species. It differs from *H. preissiana* in its semi-prostrate habit, the longer, coarser, more spreading indumentum, the generally more numerous leaf-teeth, and the very small anther appendage (0.2–0.3 mm long as compared with 1.5–3 mm).

ILLUSTRATIONS: Althofer and Harden (1980): front cover (photo), and fig. 21, No. 145A & B.

ETYMOLOGY: The specific epithet is derived from the Greek *brachys*, short and *rhynchos*,

beak, snout, referring to the short anther appendages characteristic of this species.

My thanks to Gordon Guymer (BRI) for drawing my attention to the existence of Queensland populations of this taxon and to the Director of BRI for the loan of the relevant specimens.

Reference

Althofer, G.W., & Harden, G.J. (1980) *The Flora of Mt Arthur Reserve* (Trustees of Mount Arthur Reserve: Wellington).

Manuscript received 28 July 1989
Manuscript accepted 15 December 1989

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SHORT COMMUNICATION

Asterolasia elegans (Rutaceae), a new species from the Sydney region

In 1979 a single, flowering specimen of *Asterolasia*, collected by Bill May near Maroota was submitted to the herbarium for identification. His letter noted, 'It occurs as a fairly extensive patch of thin shrubs from three to six feet tall . . .' On 25 August 1989, the population was located and flowering specimens collected. A further visit was made on 29 November 1989 to obtain mature fruiting specimens. Examination of the recently collected material has shown that it does not belong to any previously described species.

Asterolasia elegans *L. McDougall & M.F. Porteners*, **sp. nov.**

Frutex elatus, gracilis, erectus ad 3 m altus, tomento stellato, albo et ferrugineo, persaepe denso, omnino vestitus, ramis teretibus usque ad angulum 45° abeuntibus. Folia alterna, petiolata, lanceolata vel anguste lanceolata, acuminata, leniter obliqua, ad 13 cm longa, ad 25 mm lata; pagina adaxialis atrovirens, indumento stellato albo et ferrugineo, costa depressa; pagina abaxialis pallide viridis, albo-stellato-tomentose vestita, costa elevata, ferrugineo-stellato-tomentosa. Margines foliorum integrae, leniter irregulatimque undulatae, vix recurvatae, ferrugineo-stellato-tomentosae. Petioli usque ad 15 mm longi, dense ferrugineo-stellato-tomentosi. Flores albi, 1–9, in fasciculis axillaribus vel terminalibus dispositi. Pedicelli ad maturitatem usque ad 18 mm longi crescentes. Petala patentia, elliptica ad 14 mm longa, in alabastro valvata, intus glabra, extus dense albo-stellato-tomentosa, alba. Stamina 10, conspicua, glabra, c. 7 mm longa, antheris aureis. Fructus ad maturitatem albo- et ferrugineo-stellato-tomentosus. Cocci 9–10 mm alti, apice constricto. Semina c. 3 mm longa, 2 mm lata, late oblonga.

HOLOTYPE: NEW SOUTH WALES: Central Coast: near Maroota, *L. McDougall 122*, 25 Oct 1989 (NSW 220462). ISOTYPES: PERTH, CANB, K, MO.

Tall, slender, erect shrub to 3 m high, covered with white, brown and rusty stellate tomentum. Newer growth of branches, petioles and bracts densely rusty-red tomentose. *Branches* terete. *Leaves* alternate, petiolate, lanceolate to narrowly lanceolate, acuminate, slightly oblique, 4–13 cm long, 9–25 mm wide. Upper surface dark green, with white and rusty stellate hairs, the mid-vein depressed. Lower surface light green, densely white and rusty stellate-tomentose with mid-vein raised. Leaf margins entire, slightly and irregularly undulate, scarcely recurved. *Petioles* to 15 mm long, densely rusty stellate-tomentose. *Flowers* 1–9, in axillary or terminal clusters. *Pedicels* continuing to lengthen until maturity of fruit, to 18 mm long. *Calyx* vestigial. *Petals* 5, white, widely spreading, elliptic, 8–14 mm long, valvate in bud, densely white stellate-tomentose outside, glabrous inside. *Stamens* 10, conspicuous, glabrous, c. 7 mm long; anthers yellow, c. 2.5 mm long. *Gynoecium* 5-carpellate, densely covered with white stellate tomentum; style glabrous, c. 0.5 mm diam., c. 4 mm long, attached below sterile apex on adaxial side of each carpel; stigma lobed, c. 1 mm diam. *Fruit* covered with white and rusty stellate tomentum. *Cocci* 9–10 mm long, constricted at the apex. *Seeds* c. 3 mm x 2 mm , broadly oblong, shiny black, with a white waxy coating, giving the seeds a greyish appearance.

FLOWERING PERIOD: August–October; fruit maturing in November.

RANGE: Only known from one location, north of Maroota, NNW of Sydney, Central

Coast, New South Wales. A similar habitat in adjoining Marramarra National Park was searched; *A. correifolia* was frequent there with *Zieria involucrata* nearby, but *Asterolasia elegans* was not found.

HABITAT: This species occurs in sandy soil with underlying yellow clay on the southern aspect of a steep hillside above a creek in open forest of *Syncarpia glomulifera* and *Eucalyptus piperita* with understorey of wet sclerophyll plants and including a population of the rare species *Zieria involucrata*.

CONSERVATION: Just outside the northern boundary of Marramarra National Park, therefore not protected from possible road widening or other development. Suggested coding 2V, very restricted and vulnerable (Briggs & Leigh 1988).

NOTES: David Keith (National Parks and Wildlife Service of N.S.W.) visited the site in October 1989, and counted approximately 200 plants of *Asterolasia elegans*. He also counted approximately 150 plants of *Zieria involucrata*, coded 2VC, very restricted and vulnerable but represented within a conserved area (Briggs & Leigh 1988).

The new species has previously been referred to in the New South Wales Herbarium as *Asterolasia* sp. nov. aff. *hexapetala* but appears to be more closely related to *A. correifolia*, which occurs in the same region. *A. hexapetala*, a rare species found in Warrumbungle National Park, North Western Slopes, N.S.W., has leaves that are obtuse, 3–5 cm long, more obovate-oblong, paler in colour with much smaller stellate hairs, and the flowers are smaller with petals 7–9 mm long. *A. correifolia* differs from *A. elegans* in being less densely hairy and having leaves 3–9 cm long, obtuse, more ovate, with glabrous upper surface, and flowers approximately one third the size of the new species; petals 5–6 mm long. *A. correifolia* is recorded at Mill Creek, Dharug National Park, about 7 km from the Maroota site (*P.G. Richards 34, NSW*), and is frequent on sheltered hillsides of Marramarrra Creek, about 10 km from the Maroota site (*L. McDougall*, personal observation).

SPECIMENS EXAMINED: Central Coast, New South Wales: all specimens from a site near Maroota: *L. McDougall 122*, 25 Aug 1989 (NSW); *B. May*, 23 Sep 1979 (NSW); *M. Porteners 96*, 29 Nov 1989 (NSW); *L. McDougall 139*, 29 Nov 1989 (NSW).

This species is named for its elegant appearance when flowering.

Acknowledgements

The authors wish to thank Dr Peter Wilson for his assistance with the Latin description and helpful suggestions, Dr Peter Weston for his discussion of the manuscript and Dr Barry Conn for his helpful comments.

Reference

Briggs, J.D., & Leigh, J.H. (1988) *Rare or threatened Australian plants, revised edition.* Australian National Parks and Wildlife Service Special publication No. 14.

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Alma Theodora Lee
(1912 - 1990)

Alma Lee was among those who helped lift systematic botany in Australia from the low point it reached in the 1920s and 1930s towards its much more vigorous present state. Her death on 20 October 1990, aged 78, is a loss to her colleagues and to the ranks of Australian botanists.

Alma was born near the tiny northern New South Wales town of Tingha, the daughter of gold prospector and dredge operator, Wallace Melvaine. Her parents valued education highly and, partly because of this, moved to Sydney to enable her to be educated at Ascham School, to which she had won a scholarship. Her interest in plants had developed early in the still wooded countryside around Tingha and she flourished at a school that encouraged independence of mind.

At that time New South Wales had only one university and the Botany Department of the University of Sydney was headed by Professor T.G.B. Osborn (later Professor of Botany at Oxford, England). As an undergraduate she joined a department that had attracted a group of lively-minded students who were to take up important posts, including Bob Robertson (later Sir Rutherford Robertson, member of CSIRO Executive and leading adviser to the Australian Government on scientific matters), Lilian Fraser (eventually Chief of the N.S.W. Department of Agriculture Biology Branch), Joyce Vickery (deputy to the Director of Sydney's Royal Botanic Gardens), Alan Burges (Professor of Botany, Liverpool, England) and Neville White (Professor

of Plant Pathology at the University of Sydney). As undergraduates and research students they made excursions to Bulli, Colong Caves and especially to Barrington Tops and its rainforested slopes, where Fraser and Vickery made pioneering ecological surveys. These trips, in the unreliable cars that a few students could afford, greatly broadened her interest and knowledge of plants and plant communities. Discussions among these fellow students and with the zoologist Consett Davis seem to have influenced Alma Melvaine almost as much as her formal university tuition.

It was a time when ideas of evolution, genetics and systematics were coming together in an intellectual ferment, and works by Dobzhansky and Mayr were new and influential. Decades later, she maintained that her interest in genetics and biological species concepts had made her task as a systematist harder, and indeed she sometimes saw interspecific 'intergrades' where subsequent workers would see a pattern confused by an unrecognised 'new' species.

Her interest in gaining an understanding of species and subspecies in terms of population variability, hybridism, environment and evolutionary concepts was Alma's hallmark and a major part of her importance in the development of modern systematic botany in Australia.

After graduating with majors in botany and geology she spent a period as a scholarship-funded research student, still at the University of Sydney. She was unsuccessful in attempts to elucidate life cycles of *Psilotum* and *Tmesipteris* and took up studies of soil algae for her M.Sc. degree. While still a student Alma had a part-time position at the National Herbarium of New South Wales, part of Sydney's Botanic Gardens. She shared with Alan Burges both the position of 'Honorary Curator of the Cryptogams' and the annual stipend — the meagre sum of about £50. The herbarium, separated organisationally from the Gardens at that time, was a dismal place, lacking reasonable equipment, intellectual stimulation, and links with universities. There was very little opportunity for field work, and visits to other botanical institutions were very rare.

Then followed a year at the Plant Introduction Section of CSIR (later to become CSIRO) in Canberra. On resigning from that position she recommended to the Executive of CSIRO that the Division of Plant Industry should set up a herbarium, and about a year later Nancy Burbidge was appointed with that aim and CANB (Herbarium Australiense, subsequently renamed the Australian National Herbarium) was set up.

In 1938 Alma returned to the Herbarium in Sydney as a staff botanist. Much-needed change had started there and in the Gardens by that time. Robert Henry Anderson had replaced Edwin Cheel as Chief Botanist and Joyce Vickery, an associate of her university days, was a recent appointee. Much of Alma's work involved plant identifications but she took up investigations on the legumes and soon the revision of *Swainsona* was under way. The revision appeared in 1948 and was perhaps the first Australian botanical revision with a modern flavour, as evidenced by reference to it by Davis & Heywood, *Principles of Angiosperm Taxonomy* (1963), in a short list of examples of good taxonomic method and presentation. Mrs Joy Thompson, working on *Swainsona* forty years later and with a greatly increased range of specimens available, has commented on how well Alma's taxonomic judgements still stand in the light of modern knowledge. Another valuable revision largely sorted out the species — but not all the nomenclature — of *Typha* in Australia.

Leaving the Herbarium in 1947 to raise her two sons, Alma later returned in the early 1960s as a part-time botanist. Such positions were poorly paid but kept the Herbarium's research output alive during years when the time of permanent staff

was largely taken up with identifications and curation. After leaving paid part-time employment in 1982 she continued as an Honorary Research Associate of the Gardens until 1986. In these capacities she continued with the Fabaceae and published on *Bossiaea, Psoralea, Crotalaria, Platylobium, Templetonia, Hovea, Aenictophyton* A. Lee and others. She did important work on *Lupinus* with the Western Australian plant breeder J.S. Gladstones and on *Hovea* with Joy Thompson. She was senior author of the second part of the general treatment of Fabaceae in the *Flora of New South Wales* series then being produced by the Herbarium. She also turned to the monocots *Lomandra* and *Xanthorrhoea*, both notorious 'problem groups'. Her work on *Xanthorrhoea* in eastern Australia was a vast break from the confusion in earlier publications on this genus and proved a firm foundation for later, more extensive revision by Dr David Bedford.

Alma was always helpful in sharing information, and welcomed the new investigations of others who used her work as a basis but extended it. Indeed, only a few months before her death she expressed enthusiasm for the possiblity that others might use macromolecular studies to resolve some of the problems she had found intractable at least 50 years earlier.

Apart from botany and her family, her interests included playing the University of Sydney's carillon while a research student, carpentry, ceramics and playing the recorder. Long after 'official' retirement, while an Honorary Research Associate, she could often be heard playing the recorder with much younger staff members at lunch time. The bushland and plants remained a major enthusiasm. She lived at Hornsby near Sydney's outer suburban limit for much of her life, at the edge of the bush, and in her last years chose to live at Bayview largely because of its bushland setting.

In 1941 she had married David Lee, an entomologist at the University of Sydney. Most of her sixteen publications were under her married name. They separated in 1974 and later divorced. David Lee died a few days before she did. She is survived by sons James and Alister.

Alma Lee believed that an insatiable curiosity about nature was the driving force for systematists. All her life she retained an independent spirit and an impish sense of humour. She will long be remembered for her thoughtful, friendly, lively approach to life, her generous nature and for the solid body of work that she produced.

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December 1990

New taxa and new combinations in *Olearia* (Asteraceae: Astereae) from south-eastern Australia

N.S. Lander

Abstract

Lander, N.S. (Western Australian Herbarium, Department of Conservation and Land Management, P.O. Box 104, Como, WA, Australia 6052) 1991. New taxa and new combinations in Olearia *(Asteraceae: Astereae) from south-eastern Australia.* Telopea *4(2): 145-164.* Four new species of *Olearia* Moench (Asteraceae: Astereae) endemic to New South Wales are described: *O. burgessii* Lander, *O. covenyi* Lander, *O. lasiophylla* Lander, *O. montana* Lander. *Eurybia oppositifolia* F. Muell. is reinstated as *Olearia oppositifolia* (F. Muell.) Lander, also endemic to New South Wales. Two taxa previously described as varieties are raised to species rank as *O. aglossa* (Maiden & Betche) Lander (formerly *O. alpicola* var. *aglossa* Maiden & Betche), found in New South Wales and Victoria, and *O. minor* (Benth.) Lander (formerly *O. pimeleoides* var. *minor* Benth.), widespread in New South Wales, Victoria, South Australia and Western Australia. Descriptions, distribution maps and illustrations are provided, together with notes on affinities, habitat and conservation status.

Introduction

Prior to the publication of my account of *Olearia* Moench (Asteraceae: Astereae) in the forthcoming 'Flora of New South Wales' it is necessary to formally describe four new species. It is also necessary to make new combinations for three others: *Eurybia oppositifolia* F. Muell., synonymized under *Olearia chrysophylla* (DC.) Benth. by Bentham (1867) and all subsequent authors, is recognized here as a distinct species; *O. alpicola* var. *aglossa* Maiden & Betche and *O. pimeleoides* var. *minor* Benth. are raised to species rank as *O. aglossa* (Maiden & Betche) Lander and *O. minor* (Benth.) Lander respectively.

My revisionary studies of the genus *Olearia* are ongoing and it is highly likely that infrageneric concepts will change. In the meantime, species are referred to the currently accepted sections.

The descriptive terminology used in this paper follows Radford (1986). In particular, I have used 'texture' to refer to the 'substance' or 'consistency' of an organ rather than to its surface configuration.

In the course of this study specimens from the following herbaria have been examined and annotated: AD, AUCK, BH, BM, BRI, CGE, CHR, CANB, CO, DBN, DNA, ED, FI, G, HO, K, KPBG, L, LD, MEL, NSW, P, PERTH, TCD, WELT, and the private herbarium of Cyril Keith Ingram of Mt Tomah, New South Wales (to be incorporated in NSW).

Olearia aglossa *(Maiden & Betche) Lander*, **stat. et comb. nov.**

BASIONYM: *Olearia alpicola* var. *aglossa* Maiden & Betche (1899: 147); Maiden & Betche (1916: 193).

TYPE CITATION: 'Jindabyne (W. Bäuerlen, January, 1890); Sawpit Creek, Mt Kosciusko (J.H. Maiden, January, 1898, and 1899).'

SYNTYPES: NEW SOUTH WALES: Southern Tablelands: Jindabyne, Snowy River, *W. Bäuerlen s.n.*, 17 Jan 1890 (NSW 179207); Mt Kosciusko, Sawpit Creek, *J.H. Maiden s.n.*, Jan 1898 (MEL 36427, NSW 179208).

POSSIBLE SYNONYM: *Eurybia alpicola* var. *rhodochaeta* F. Muell. (1860b: 230). TYPE CITATION: 'In tractu Cobboras Mountains.' TYPE: not located (? MEL) — see Typification.

Shrubs to 1 m high. *Vestiture* of stems, abaxial surface of leaves and involucral bracts of intricate, multicellular, divaricately forked (T-shaped), eglandular hairs. *Stems* ascending, densely pale-brown-tomentose, becoming grey. *Leaves* opposite, spreading, petiolate; petiole stout, to 12 mm long; lamina flat, ovate, 24–90 x 8–27 mm, discolorous, green and glabrous adaxially, densely pale-brown-tomentose abaxially; texture coriaceous; venation obscure, reticulate; base acute or rounded; margin entire, weakly revolute; apex acute, mucronulate. *Heads* in terminal, corymbose conflorescences, pedunculate, disciform or radiate, 4–20 mm diam.; disc 2–5 mm diam. *Peduncles* to 25 mm, with several small bracts merging into those of the involucre. *Involucre* narrowly conic; bracts 4–6-seriate, 2–5.3 x 1.1–1.5 mm. *Outer involucral bracts* ovate, flat; stereome greyish green and uniformly loosely tomentose abaxially; margin narrow, membranous, fimbriate; apex obtuse. *Inner involucral bracts* narrowly obovate, flat; stereome pale green and uniformly loosely tomentose abaxially; margin broad, membranous, fimbriate; apex broadly acute, with dense, multicellular, biseriate, capitate, glandular hairs. *Receptacle* convex. *Marginal florets* 2–4, female, uniseriate; corolla mostly filiform (rarely radiate), 4.4–10 mm long; tube glabrous; ligule (if present) ovate, c. 6.5 x 1.5 mm, white, glabrous, acute and minutely 3-lobed apically; stylar arms narrowly ligulate, 1.3–1.5 mm long. *Disc florets* 2–4, bisexual; corolla narrowly infundibular, 5.5–6 mm long, yellow, glabrous; lobes 5, narrowly triangular, c. 2 mm long; anthers 2.4–2.6 mm long, sagittate and shorter than the filament collar basally, with narrowly ovate, terminal appendages; filament collar 0.7–0.8 mm long; stylar arms half-cylindric or half-clavate, 1.2–3 mm long, with triangular, sterile apical appendages bearing minute, botuliform papillae above the stigmatic lines. *Achene* narrowly obovoid, 0.3–0.5 x 1.3–2 mm, light brown, glabrous or with apical tuft of duplex hairs, with 6-8 more or less prominent ribs; base acute with conspicuous central carpopodium. *Pappus* biseriate; bristles 53–75, minutely barbellate, pink, more or less equal in length to the disc corolla. Figure 1.

DISTRIBUTION: Southern Tablelands of New South Wales and in the Victorian Alps (Figure 2).

HABITAT: Dry sclerophyll forest in mountainous areas.

FLOWERING PERIOD: December to February.

TYPIFICATION: Of the syntypes of *Olearia alpicola* var. *aglossa* cited in the protologue (Mueller 1860b), Maiden's Sawpit Creek specimen collected in 1899 has not been located.

At the end of the protologue of *Eurybia alpicola* F. Muell. [= *Olearia alpicola* (F. Muell.) F. Muell. ex Benth.], Mueller (1860b) describes an infraspecific taxon as *'ß — rhodochaeta'*. Although no type or other original material of *E. alpicola* var. *rhodochaeta* has been located, Mueller's diagnosis of it is consistent with material examined of

Figure 1. *Olearia aglossa*. **a,** habit. **b,** marginal floret. **c,** disc floret. **d,** stylar arms (from disc floret). **e,** anther. **f,** multicellular, biseriate, capitate, glandular hair (from inner involucral bract). **g,** multicellular, divaricately forked (T-shaped), eglandular hair (from leaf). From *J.H. Maiden s.n.* (syn NSW 179208). Scale bars: a, b, c = 1 mm; d, e, f = 0.5 mm

O. aglossa, noting the pink pappus bristles ('pappi setis roseis'). Maiden & Betche (1899) observe that 'specimens of *O. alpicola* from the Cobberas Mountains in Victoria, collected by F. v. Mueller, ... agree precisely with the rayless Mt Kosciusko form [i.e. their *O. alpicola* var. *aglossa*], except in the presence of the ray-flowers'; these specimens are possibly to be found amongst the *Olearia* material held in the supplementary collections at MEL. Although Maiden & Betche thus cite what would seem likely to be types of Mueller's *Eurybia alpicola* var. *rhodochaeta*, they do not actually mention the latter name. It is very likely that this is a synonym of *O. aglossa*.

Affinities: The presence of divaricately forked trichomes on the vegetative surfaces of *Olearia aglossa* are typical of *Olearia* sect. *Dicerotriche* Archer ex Benth., where this species is best retained. Its affinities would seem to lie with *O. alpicola* from which it is readily distinguished: the leaves of *O. alpicola* are linear or elliptic; its heads are 19–24 mm diam. with 6–7 marginal florets which are conspicuously ligulate, and 9–11 disc florets; and its pappus is of 61–85 white or straw-coloured bristles. The more widespread *O. alpicola* is found on the South Coast, Northern Tablelands, Southern Tablelands and North Western Slopes of New South Wales, and in the Victorian Alps.

Notes: *Olearia aglossa* appears to be unique amongst the *Dicerotriche* in the variable morphology of its marginal florets. Similar variation and reduction in the size of marginal florets (and even their complete absence) occurs independently in various species groups of *Olearia* which are otherwise typical of the genus — amongst the *O. axillaris*/*O. tubuliflora* group (section *Eriotriche* Archer ex Benth.) in Western Australia and South Australia, for instance.

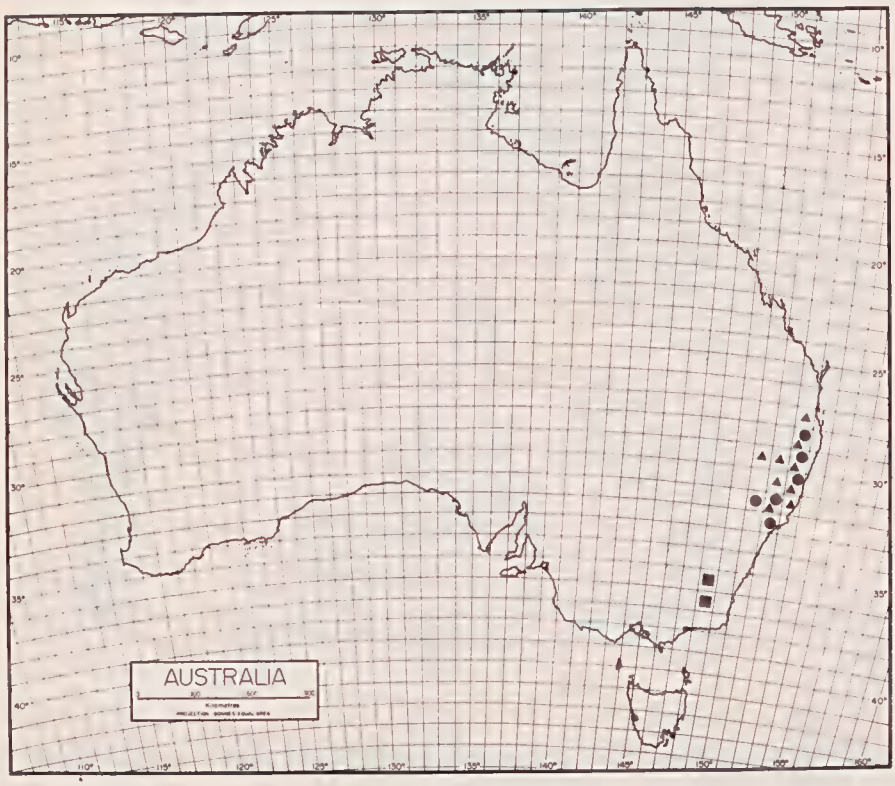

Figure 2. Distribution of *Olearia aglossa* (■), *O. covenyi* (●) and *O. oppositifolia* (▲) indicating occurrence in 1° squares.

Conservation status: This species has a maximum geographic range of about 80 km and was last collected in 1954. It appears to warrant the category 2K of Briggs & Leigh (1988).

Etymology: The specific epithet refers to the fact that the marginal florets of this taxon are usually filiform, lacking a distinct ligule.

Other specimens examined: New South Wales: Southern Tablelands: Tumut Pond Reservoir [as 'Tumut Ponds'], *G.W. Althofer s.n.*, Feb 1954 (NSW); Mt Kosciusko, *J. McLuckie 101*, Feb 1928 (CANB); s. loc., s. coll.,– [ex herb. W. Woolls] (NSW 127482).

Olearia burgessii *Lander,* **sp. nov.**

Species nova *Olearia ramulosae* probabiliter affinis a qua deficientia pilorum hispidorum, conicorum, multicellularium, uniseriatorum simplicium, eglandulosorum, praeclare distinguitur.

Type: New South Wales: Central Coast: Thirlmere, *C.E.B.H. Burgess s.n.*, 6 October 1959 (holo NSW, iso PERTH).

Shrub to 1.8 m high. *Vestiture* of stems, leaves and involucral bracts of intricate, multicellular, simple, flagellate, eglandular hairs and multicellular, biseriate, capitate, glandular hairs. *Stems* ascending, grey-tomentose, becoming reddish brown and subglabrous. *Leaves* alternate, scattered, spreading, sessile or subsessile; petiole to 2 mm long; lamina flat, obovate or elliptic, 3–13 x 1–4 mm, discolorous, green and glabrous or with eglandular and glandular hairs scattered adaxially, grey-tomentose abaxially; texture chartaceous; venation indistinct apart from midvein; base narrowly cuneate; margin entire, weakly revolute; apex acute or rounded, muticous. *Heads* pedunculate, solitary, axillary or terminal on lateral (sometimes much reduced) branchlets, forming loose, leafy, paniculate conflorescences, radiate, 10–16 mm diam.; disc 5–8 mm diam. *Peduncles* to 12 mm long, with several small bracts grading into those of the involucre. *Involucre* campanulate; bracts 3–4-seriate, 2.2–4 x 0.8–1 mm. *Outer involucral bracts* somewhat carinate; stereome green, with eglandular hairs scattered uniformly and abaxially; margin narrow, membranous, fimbriate; apex acute with dense patch of eglandular and glandular hairs abaxially. *Inner involucral bracts* narrowly obovate, flat; stereome pale green, with eglandular hairs scattered abaxially and apically;margin narrow, membranous, fimbriate; apex acute with dense patch of eglandular and glandular hairs abaxially. *Receptacle* slightly convex. *Marginal florets* 8–11, female, uniseriate; corolla radiate, 7–7.5 mm long; tube with multicellular, biseriate, simple, eglandular hairs scattered apically; ligule narrowly ovate, 4–5.8 x 0.8–1.5 mm, white, glabrous, obtuse and minutely emarginate apically; stylar arms filiform, 1–1.5 mm long. *Disc florets* 6–10, bisexual; corolla infundibular, 3.7–4.6 mm long, yellow; tube with scattered, multicellular, biseriate, simple, eglandular hairs; lobes narrowly triangular, 1.3–1.5 x 0.4–0.6 mm; anthers 1.5–1.7 mm long, basally obtuse, with narrowly triangular sterile, terminal appendages; filament collar exceeding the anthers, 0.3–0.4 mm long; stylar arms half-ellipsoid, 1.1–1.3 mm long, with triangular, sterile apical appendages bearing minute, botuliform papillae above the stigmatic lines. *Achene* narrowly obovoid, 1.5–2 x 0.5–0.6 mm, light brown, ± 8-ribbed, more or less sericeous with duplex hairs. *Pappus* 2-seriate; bristles 26–40, more or less equal to the disc corolla, with or without an outer row of short bristles. Figure 3.

Distribution: Central Coast, Central Tablelands and Southern Tablelands of New South Wales (Figure 4).

Habitat: In sandy loam over sandstone or shale, amongst dry sclerophyll forest.

Flowering period: July to November.

Figure 3. *Olearia burgessii*. **a,** habit. **b,** marginal floret. **c,** disc floret. **d,** stylar arms (from disc floret). **e,** anther. **f,** multicellular, biseriate, simple, eglandular hair (from disc floret). **g,** multicellular, biseriate, capitate, glandular hair (from leaf). From C. *Burgess s.n.* (holo NSW 182674). Scale bars: a = 1 cm; b, c = 1 mm; d, e = 0.5 mm.

AFFINITIES: The preponderance of intricate, simple trichomes on the vegetative surfaces of *Olearia burgessii* is typical of *Olearia* sect. *Eriotriche* Archer ex Benth. where this species would seem best retained. Its affinities within sect. *Eriotriche* are as yet obscure but may lie with the rather variable and widespread *O. ramulosa* (Labill.) Benth., from which it is readily distinguished by the complete absence of hispid, conic, multicellular, uniseriate, simple, eglandular hairs.

NOTES: Specimens of this species have been variously placed in herbaria under *Olearia ramulosa* (Labill.) Benth. and *O. phlogopappa* (Labill.) DC.

CONSERVATION STATUS: This species is known from two populations some 400 km apart and was last collected in 1971. It appears to warrant the category 3K of Briggs & Leigh (1988).

ETYMOLOGY: The specific epithet honours the late Rev. Colin Ernest Bryce Hawthorn Burgess (1907-1988), a keen amateur botanist, some of whose collections are held at NSW.

OTHER SPECIMENS EXAMINED: NEW SOUTH WALES: Central Coast: Burragorang Lookout, *D.F. Blaxell s.n.*, Nov 1961 (NSW); Hill Top, 1929, *E. Cheel s.n.*, 1929 (NSW, PERTH); Hill Top, E. Cheel *s.n.*, Nov 1930 (NSW); Bargo River, near Tahmoor, *H. Salasoo 4786*, Oct 1971 (NSW). Central Tablelands: Silverdale Road, *E.F. Constable 3971*, July 1947 (NSW). Southern Tablelands: Germanton & Tumbarumba, *W. Forsyth s.n.*, Nov 1900 (NSW, PERTH).

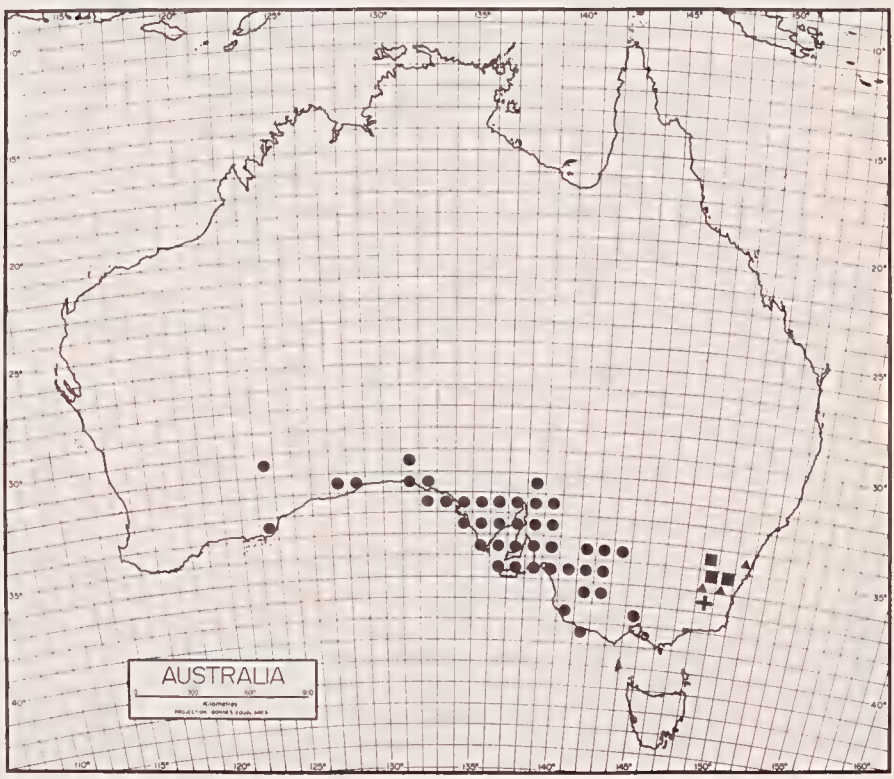

Figure 4. Distribution of *Olearia burgessii* (▲), *O. lasiophylla* (+), *O. minor* (●) and *O. montana* (■) indicating occurrence in 1° squares.

Olearia covenyi *Lander*, **sp. nov.**

Species nova Ole*ariae megalophyllae* affinis a qua capitulis diametro minore (16.4–22 mm cf. 22.6–32 mm), flosculis paucioribus radiatis (2–4 cf. 5–9) et discis (3–4 cf. 9–14) praeclare distinguitur.

TYPE: NEW SOUTH WALES: Northern Tablelands: Gloucester Tops, *R.G. Coveny s.n.*, 1 January 1967 (holo NSW 127260; iso PERTH).

[*O. chrysophylla* var. *wilcoxii* F. Muell. ex Maiden et Betche (1916: 193), nom. inval. — see Notes.]

Shrub to 3 m high. *Stems* ascending, yellowish brown and densely tomentose, smooth. *Vestiture* of stems, leaves and outer involucral bracts of multicellular, uniseriate, divaricately forked (T-shaped), eglandular hairs. *Leaves* opposite, scattered, inclined, petiolate; petiole to 18 mm long, stout; lamina flat, ovate, 23–130 x 12–50 mm, discolorous, green and glabrous adaxially, yellowish brown and densely tomentose abaxially; texture coriaceous; venation distinct, reticulate; base rounded; margin entire, weakly revolute; apex rounded or obtuse, mucronulate. *Heads* in terminal, compound corymbose conflorescences, pedunculate, radiate, 16.4–22.2 mm diam.; disc 3–5 mm diam. *Peduncles* to 11 mm long, ebracteate. *Involucre* narrowly conic; bracts 3–4-seriate, 1.6–6.2 x 0.9–1.3 mm. *Outer involucral bracts* triangular, strongly carinate; stereome pale greenish brown, densely tomentose; margin membranous, fimbriate; apex broadly acute. *Inner involucral bracts* narrowly triangular or linear, somewhat carinate; stereome pale greenish brown, bearing divaricately forked, eglandular hairs centrally to apically and scattered, multicelluar, uniseriate, capitate, glandular hairs basally; margin membranous, fimbriate apically; apex narrowly acute. *Receptacle* convex. *Marginal florets* 2-4, female, uniseriate; corolla radiate, 10.9–12.5 mm long; tube glabrous; ligule elliptic or ovate, 6.7–8.6 x 1.9–2.9 mm, white, glabrous, acute and minutely 3-lobed; stylar arms narrowly clavate, 1.2–1.7 mm long. *Disc florets* 3–4, bisexual; corolla infundibular, 6.0–8.3 mm long, yellow, glabrous; lobes 5, narrowly triangular, 1.5–2.0 mm long; anthers 2.2–2.7 mm long, sagittate and shorter than the filament collar basally, with ovate terminal appendages; filament collar 0.5–0.6 mm long; stylar arms 1.5–1.7 mm long, with half-clavate apical apendages bearing botuliform papillae above the stigmatic lines. *Achene* narrowly obovoid, flattened, 2.0–2.9 x 0.5–0.7 mm, brown, glabrous, with 6–8 prominent ribs; base acute with conspicuous, central carpopodium. *Pappus* biseriate; bristles 41–82, minutely barbellate, more or less equal in length to the disc corolla. Figure 5.

DISTRIBUTION: North Coast, Northern Tablelands, and North Western Slopes of New South Wales (Figure 2).

HABITAT: In wet sclerophyll forests in mountainous areas.

FLOWERING PERIOD: November to December.

AFFINITIES: The presence of divaricately forked trichomes on the vegetative parts of *Olearia covenyi* is typical of *Olearia* sect. *Dicerotriche* Archer ex Benth. where this species is best placed. Its affinities would seem to lie with *O. megalophylla* (F. Muell.) F. Muell. ex Benth. from which it is readily distinguished: the heads of *O. megalophylla* are 22.6–32 mm diam. with 5–9 ray florets and 9–14 disc florets. These two species are geographically disjunct and also differ in their flowering times: *O. megalophylla* is found on the Central Tablelands, Southern Tablelands and South Western Slopes of New South Wales, and in Victoria; it flowers from December to March.

NOTES: Specimens of this taxon held at MEL and NSW, including those of H. Beckler cited below, have been annotated by F. Mueller as '*Aster wilcoxii*', a name never

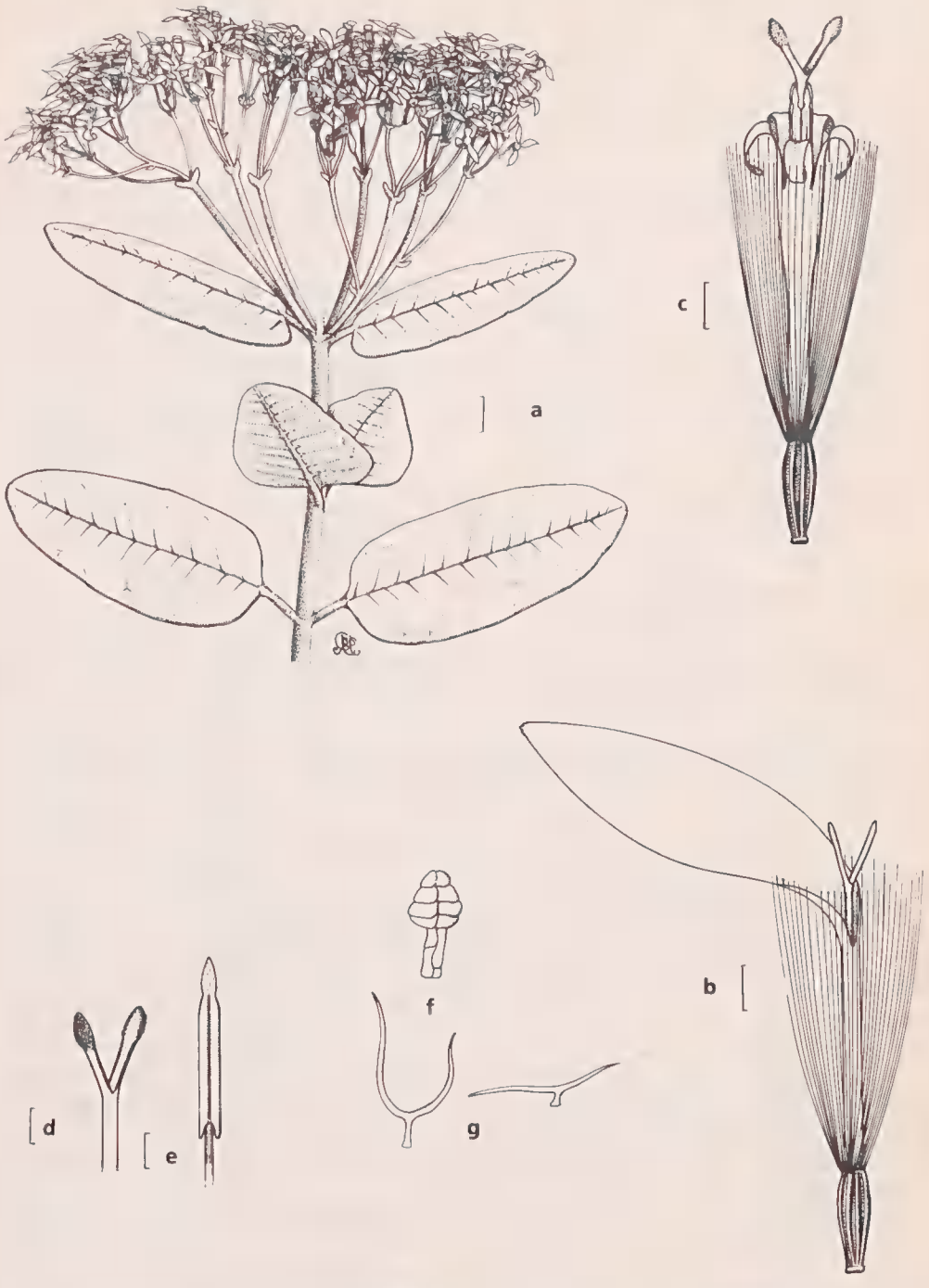

Figure 5. *Olearia covenyi*. **a,** habit. **b,** marginal floret. **c,** disc floret. **d,** stylar arms (from disc floret). **e,** anther. **f,** multicellular, biseriate, capitate, glandular hair (from inner involucral bract). **g,** multicelluar, uniseriate, divaricately forked, eglandular hairs (from leaf). From *R.G. Coveny s.n.* (holo NSW 127260). Scale bars: a = 1 cm; b, c = 1 mm; d, e = 0.5 mm.

actually published by Mueller or anyone else. Maiden & Betche (1916) note '*O. chrysophylla* var. *wilcoxii* F.v.M. M.S. in Melb. Herb.'; however, they provide neither a description or diagnosis of it nor a reference to a previously and effectively published description or diagnosis. In the event, the epithet is preoccupied at species rank in *Olearia* by *O. wilcoxii* Petrie, a New Zealand taxon.

Conservation status: This species is widely distributed, occurs in areas unlikely to experience a change in land use and is well collected. It is considered neither rare nor endangered.

Etymology: The specific epithet honours Robert George Coveny (1943–), whose extensive collections have done so much to extend our knowledge of the flora of New South Wales.

Other specimens examined: New South Wales: North Coast: Macleay River, *H. Beckler s.n.*, Nov 1875 (MEL, NSW 127265 p.p.); Bellingen, *G. Hewitt s.n.*, Dec 1949 (NSW). Northern Tablelands: head of Bellingen River [as 'Bellinger'], *Anonymous*, 1864 (NSW); upper Clarence River, *H. Beckler s.n.*, Nov 1875 (MEL, NSW 127265 p.p.); Yarrowitch, *J.L. Boorman s.n.*, Dec 1912 (NSW); 'Guy Fawkes' & Round Mt, *J.L. Boorman s.n.*, Dec 1909 (NSW, PERTH); Murrurundi, *R.H. Cambage s.n.*, Oct 1907 (NSW); Mt Bajimba, c. 18 miles [29 km] SSE of Tenterfield, *E.F. Constable* 7076, Aug 1966 (NSW, PERTH); Gloucester Tops, *R.G. Coveny s.n.*, Jan 1967 (NSW); Kholwha Trail, Barrington Tops, *C.K. Ingram & P.D. Hind s.n.*, Feb 1983 (herb. C.K. Ingram); 'Perretts', Tyringham & 'Bald Hill', Grafton–Armidale road, *J.H. Maiden s.n.*, Dec 1893 (NSW 17961, 1272667, 127484); 'Guy Fawkes' & Round Mt, *J.H. Maiden s.n.*, Dec 1893 (NSW); Yarrowitch, *J.H. Maiden s.n.*, Nov 1897 (NSW). North Western Slopes: Nundle, *M.H. Simons* 23, July 1913 (NSW).

Olearia lasiophylla *Lander*, **sp. nov.**

Species nova *Oleariae stellulatae* affinis sed pubescentia in superficiebus ambabus foliorum (folia *O. stellulatae* adaxialiter glabra vel subglabra, abaxialiter tomentulosa cinerea) et capitulis solitariis vel paucis diametro 22.4–27 mm (cf. conflorescentiae *O. stellulatae* foliosae paniculatae diametro 11–23.8 mm) praeclare distinguitur.

Type: New South Wales: Southern Tablelands: Grass Flat Creek, Pinnacle Road, W of Mt Townsend, *N.C. Ford 76*, 9 Jan 1959 (holo NSW 181859; iso CHR, MEL, PERTH).

Shrub to 1 m high. *Vestiture* of stems, leaves and involucral bracts of loose, intricate, multicellular, stellate, eglandular hairs. *Stems* ascending, densely stellate-hairy, yellowish becoming brown. *Leaves* alternate, scattered, subsessile; petiole to 4 mm long; lamina flat, elliptic, 7–55 x 4–16 mm, discolorous, dark green adaxially, pale green abaxially, densely stellate-hairy on both surfaces; texture flaccid; venation conspicuous, reticulate; margin entire or sinuate or coarsely dentate, flat; apex acute or obtuse, muticous. *Heads* terminal, on short branchlets, solitary or in small clusters, radiate, 22.4–27 mm diam., disc 0.8–1.3 mm diam.*Peduncles* to 34 mm, with several leaf-like bracts grading into those of the involucre. *Involucre* hemispheric; bracts 3–4-seriate, 2.8–6 x 0.8–2 mm. *Outer involucral bracts* triangular, carinate; stereome dark green and more or less uniformly and loosely stellate-hairy abaxially with multicellular, biseriate, glandular hairs scattered basally; margin undifferentiated, entire; apex acute. *Inner involucral bracts* narrowly elliptic, flat; stereome light green, subglabrous, with stellate hairs scattered apically; margin broad, membranous, entire; apex acuminate, fimbriate. *Marginal florets* 14–15, female, uniseriate; corolla radiate, 14–16 mm long; tube with multicellular, biseriate, simple, eglandular hairs scattered apically; ligule narrowly elliptic, 10–11 x 2.4–3 mm, white, glabrous, minutely 3-lobed apically; stylar arms filiform, 1.3–2 mm long. *Disc florets* 9–15, bisexual; corolla infundibular, 5.5–6.8 mm long, yellow, with multicellular, biseriate, simple, eglandular hairs scattered centrally to apically; lobes 5, triangular, 1.3–1.5 mm long; anthers 1.7–2 mm long, minutely sagittate and shorter than the filament collar basally, with narrowly triangular, sterile,

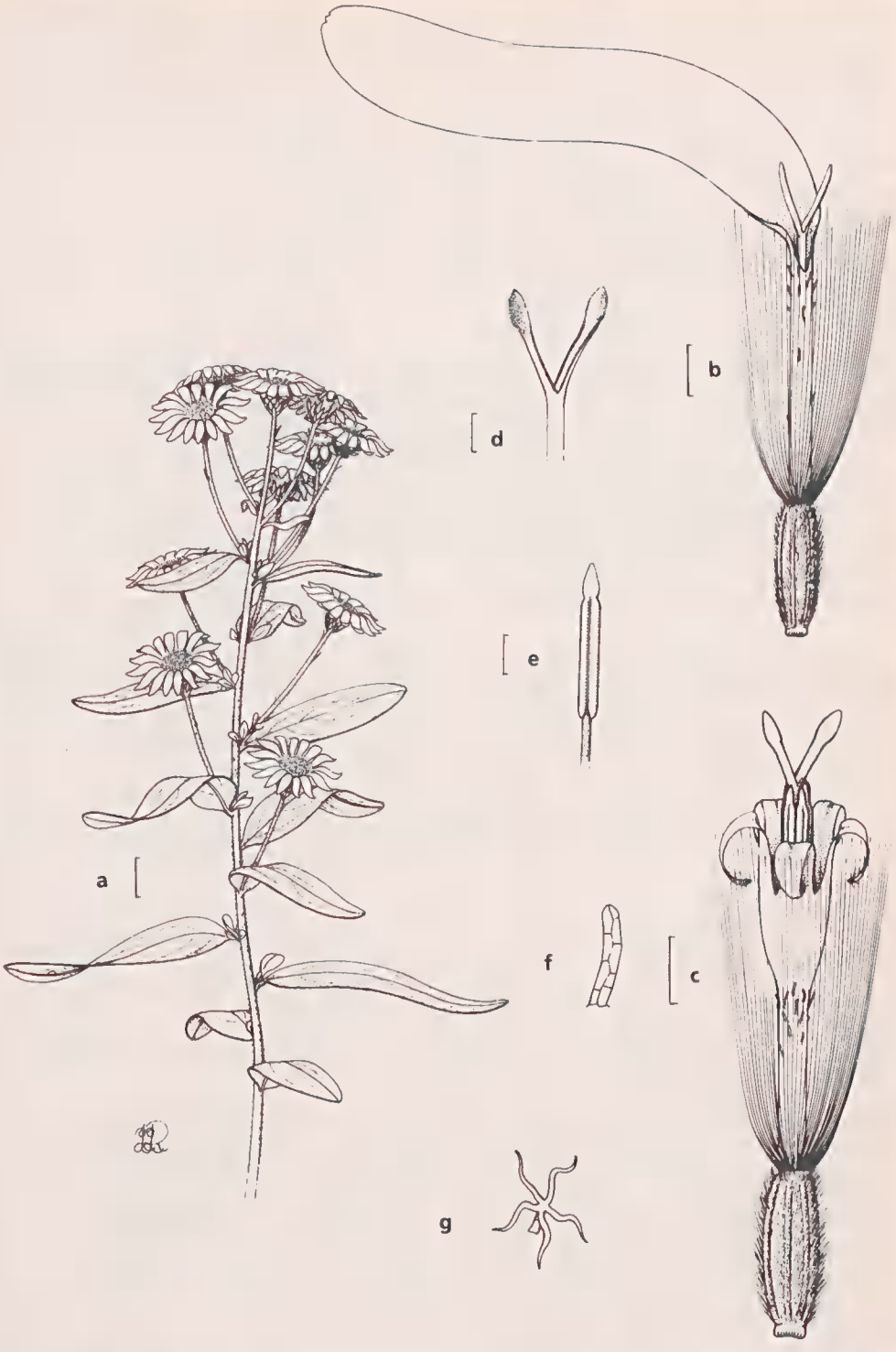

Figure 6. *Olearia lasiophylla*. **a,** habit. **b,** marginal floret. **c,** disc floret. **d,** stylar arms (from disc floret). **e,** anther. **f,** multicellular, biseriate, simple, eglandular hair (from disc floret). **g,** multicellular, stellate, eglandular hair (from leaf). a & g from *N.C. Ford 76* (holo NSW 181859). c-f, from *M.E. Phillips 3517* (NSW). Scale bars: a = 1 cm; b, c = 1 mm; d, e = 0.5 mm.

terminal appendages; filament collar 0.5–0.6 mm long; stylar arms half clavate, 1–1.5 mm long, with half-clavate, sterile, apical appendages bearing botuliform papillae above the stigmatic lines. *Achene* flattened obovoid, 2.4–3.5 x 0.8–1 mm, light brown, sericeous with duplex hairs, 5-ribbed; base more or less acute, with conspicuous, central carpopodium. *Pappus* 2-seriate; bristles 39–52, more or less equal to the disc corolla in length, and an outer row of short bristles. Figure 6.

Distribution: Restricted to the vicinity of Geehi Reservoir on the Southern Tablelands of New South Wales (Figure 4).

Habitat: Montane sclerophyll forests with *Eucalyptus delegatensis* R. Baker, on steep slopes.

Flowering period: November to February.

Affinities: The presence of stellate hairs on the vegetative parts of *Olearia lasiophylla* is typical of *Olearia* sect. *Asterotriche* Archer ex Benth. (Bentham 1867), where this species would seem best placed. Its affinities appear to lie with *O. stellulata* (Labill.) DC., from which it is readily distinguished: the leaves of *O. stellulata* are glabrous or subglabrous adaxially and minutely grey-tomentose abaxially; its heads are in leafy, paniculate conflorescences and are 11–23.8 mm diam. The more widespread *O. stellulata* is found on the North, Central and South Coast and Tablelands of New South Wales, and in the Victorian and Tasmanian Alps.

Notes: Specimens of this species have been placed under *O. stellulata* in herbaria.

Conservation status: This species has a maximum geographic range of about 15 km, is confined to the Kosciusko National Park and was last collected in 1972. It appears to warrant category 2KC of Briggs & Leigh (1988).

Etymology: The specific epithet refers to the loosely hairy leaves characteristic of this taxon, from Greek *lasio-*, woolly and *-phylla*, leaved.

Other specimens examined: New South Wales: Southern Tablelands: 6.7 km SW of Geehi Reservoir Substation, *P.N. Martensz 583*, Feb 1972 (CANB); Pinnacle Track, above Geehi, *M.E. Phillips 3517*, Nov 1958 (NSW).

Olearia minor *(Benth.) Lander*, **stat. et comb. nov.**

Basionym: *Olearia pimeleoides* var. *minor* Benth. (1867: 479); Ewart (1931: 1114); Black (1965: 870); Jessop (1984: 67).

Type citation: 'Murray desert, *F. Mueller*; Rotton Island, *Wilhelmi.*'

Lectotype (here designated): South Australia: Murray: Murray River, *F. Mueller s.n.*, – (lecto K) — see Typification.

Lectoparatypes: South Australia: Eyre Peninsula: Boston Island, *[J.F.C.] Wilhelmi s.n.*, – (MEL 1543742); Boston Island, *[J.F.]C. Wilhelmi s.n.*, 1851 (MEL 1543738, p.p.). Murray: Murray Desert, *F. Mueller s.n.*, – (MEL 1543743). — see Typification.

Misapplied names: *Olearia floribunda* auct. non (J. Hook.) Benth.: Wakefield (1956: 96); Willis (1973: 693), p.p.— see Notes.

Olearia brachyphylla auct. non (F. Muell. ex Sonder) Wakef.: Cooke in Jessop & Toelken (1986: 1477, fig. 671a), p.p. — see Notes.

Shrub to 1.5 m. *Vestiture* of stems, leaves and involucral bracts of multicellular, uniseriate, simple or sometimes dendritic, eglandular hairs and scattered multicellular, biseriate, capitate, glandular hairs. *Stems* ascending, greyish green becoming dark brown, pannose with eglandular and glandular hairs. *Leaves* alternate, scattered,

sessile; lamina flat, obovate or elliptic, 1.5–8 x 1–2.5 mm, discolorous, adaxially green and subglabrous, abaxially grey-lanate; texture subcoriaceous; venation indistinct; base attenuate; margin entire, revolute; apex broadly acute or rounded, muticous. *Heads* terminal, solitary or in clusters of 2 or 3, subsessile, conspicuously radiate, 11.6–22 mm diam.; disc 4–7 mm diam. *Involucre* conic; bracts 4–5-seriate, 1.9–5.3 x 0.7–1.5 mm. *Outer involucral bracts* ovate, carinate; stereome pale green or yellow and densely lanate centrally to apically abaxially; margin chartaceous or membranous, slightly fimbriate; apex acute or rounded, ciliate. *Inner involucral bracts* linear or narrowly elliptic, somewhat carinate; stereome green, subglabrous to densely lanate apically; margin membranous, entire; apex acute or rounded, fimbriate. *Receptacle* weakly convex. *Marginal florets* 7–12, female, uniseriate; corolla radiate, 5.7–10.7 mm long; tube with eglandular hairs scattered apically; ligule elliptic or obovate, 3.8–7.5 x 1–2.5 mm, white, glabrous, minutely 3-lobed or sometimes emarginate apically; stylar arms filiform, 1.2–1.8 mm long. *Disc florets* 6–13, bisexual; corolla infundibular, 3.8-6 mm long, yellow, with eglandular and glandular hairs scattered apically; lobes 5, narrowly triangular, 0.9–1.8 mm long; anthers 1.3–1.9 mm long, obtuse to minutely sagittate, and shorter than filament collar basally, with triangular or obovate, sterile, terminal appendages; filament collar 0.3–0.5 mm long; stylar arms 1–1.7 mm long, with half-conic, sterile, apical appendages bearing botuliform papillae. *Achene* narrowly ellipsoid or obovoid, 0.8–1.7 x 0.3–0.6 mm, pale brown, subglabrous or densely glandular; carpopodium conspicuous, oblique. *Pappus* 1–2–3)-seriate; bristles 37–65, barbellate, more or less equal to the disc corolla in length, and (rarely) a third outer series of much shorter bristles.

Distribution: South Far Western Plains of New South Wales; Melbourne, North Central, Mallee, Wimmera and South West Study Areas of Victoria; Nullarbor, Flinders Ranges, Eastern, Eyre Peninsula, Northern Lofty, Murray, Yorke Peninsula, Southern Lofty, Kangaroo Island and South Eastern Regions of South Australia; the Eucla and Helms Districts of the Eremaean Botanical Province and the Roe District of the South-West Botanical Province of Western Australia (Figure 4).

Habitat: In red-brown loam or yellow-brown sand, on dunes or rocky slopes over sandstone or limestone, amongst mallee or open shrubland.

Flowering period: June to November.

Typification: Although the specimen at K chosen as the lectotype is labelled 'Murray River' it is clearly annotated by Bentham '*Olearia pimeleoides* var. *minor*'. A small, supplementary label reads: 'FLORA AUSTRALIENSIS, Named by Mr. Bentham.'

The lectoparatype held at MEL bearing the locality 'Murray Desert' is annotated simply '*Eurybia*'; the reverse of its label has been initialled by Bentham.

One of the lectoparatypes of *Olearia pimeleoides* var. *minor*, collected at Boston Island by J.F.C. Wilhelmi (MEL 1543742), bears a label annotated '*Eurybia pimeleoides* var.'; the reverse of its label has been initialled by Bentham; an apparent duplicate of this (MEL 1543738 p.p.) bears a label annotated '*Eurybia* s', also initialled on the reverse by Bentham; both specimens are clearly conspecific with the lectotype. However, a further lectoparatype held at K bearing the same collecting details and annotated by Bentham as '*Olearia pimeleoides* var. *minor*' is clearly referable to *O. exiguifolia* (F. Muell.) F. Muell. ex Benth. I can find no reference to a locality named 'Rotton Island' either in gazetteers or on any of the labels of the 12000 or so specimens of *Olearia* examined in the course of my studies on this genus, thus I take it for a simple transcription error for Boston Island, situated off Port Lincoln in South Australia.

Affinities: The presence of intricate dendritic hairs on the vegetative parts of *Olearia minor* is typical of *Olearia* sect. *Eriotriche* where this species would seem best retained.

Its affinities appear to lie with *O. pimeleoides* (DC.) Benth. sens. strict. from which it is readily distinguished: the leaves of *O. pimeleoides* are 3-25 x 1-6.5 mm; its heads are pedunculate (with peduncles to 85 mm long) and are 20.5-30 mm in diameter, with 8-25 ray florets and 14-29 disc florets. *O. pimeleoides* sens. strict. is found extensively in New South Wales, southern Queensland, Victoria, South Australia and Western Australia.

NOTES: Specimens of *Olearia minor* have been a source of much confusion in the literature where they have been placed under various species in *Olearia sect. Eriotriche*, notably *O. brachyphylla*, *O. floribunda*, and *O. pimeleoides*. In herbaria they have also been placed under *O. exiguifolia* and *O. iodochroa* (F. Muell.) F. Muell. ex Benth.

Cooke (in Jessop & Toelken 1986: 1477-8) has interpreted *Olearia brachyphylla* very broadly, synonymizing under it both *O. exilifolia* (F. Muell.) Benth. and *O. pimeleoides* var. *minor*. I have circumscribed *O. brachyphylla* more narrowly, uniting it with *O. exilifolia* but maintaining *O. pimeleoides* var. *minor* as a distinct taxon worthy of specific rank. *O. minor* is not at all easily confused with *O. brachyphylla*. Notably, the leaves of *O. brachyphylla* are oblong, 2-3 x 0.5-1 mm and incurved; and its heads are 3-4 mm in diameter with 2-3 ray florets and 3-4 disc florets. *O. brachyphylla* is disjunct in its distribution, occurring in the Eyre Peninsula, Murray, South Eastern and Southern Lofty Regions of South Australia, and in the Eyre District of the South-West Botanical Province of Western Australia.

Wakefield (1956: 96) and Willis (1973: 693) included specimens of *Olearia minor* under *O. floribunda*. Willis suggested that these may be of hybrid origin: I can see nothing to support this contention. *Olearia minor* is readily distinguished from *O. floribunda*. The leaves of the latter are crowded and 0.3-1 mm wide with flat margins; its heads are 8-13 mm in diameter with 3-7 ray florets and 3-9 disc florets, and they are arranged in exceedingly dense, leafy, paniculate conflorescences; its pappus comprises 27-37 long bristles with an outer row of much shorter bristles. *O. floribunda* is widely distributed on the Central and South Western Slopes, Southern Tablelands and South Western Plains of New South Wales; the Eastern Highlands and West Gippsland Coastal Plain of Victoria; the Eastern, Eyre Peninsula, Murray, South Eastern, Southern Lofty and Yorke Peninsula Regions of South Australia; and in Tasmania.

Willis (1973: 692) notes under *Olearia iodochroa* 'mauve-headed populations' from the Brisbane Ranges of Victoria, referred here to *O. minor*, suggesting that these may have arisen as a result of hybridism between *O. pimeleoides* and *O. ramulosa* (Labill.) Benth. Like those of many Astereae, the white ligules of the ray florets of this suite of specimens sometimes dry mauve; however, there is nothing on their labels to suggest that they exhibit this colour in life. Again there is nothing to suggest that *O. minor* is of hybrid origin: *O. minor* is easily distinguished from *O. iodochroa*. The leaves of the latter are densely yellowish lanate abaxially; its involucral bracts have characteristically dark purple margins; its heads have 15-20 ray florets. *O. iodochroa* is confined to the Southern Tablelands of New South Wales and the Eastern Highlands of Victoria and does not overlap geographically with *O. minor*.

For the differences between *O. minor* and *O. pimeleoides* see the diagnosis and Affinities above.

CONSERVATION STATUS: This species is very widely distributed across southern arid Australia, occurs in several National Parks, and is well collected. It is considered neither rare nor endangered.

ETYMOLOGY: The specific epithet refers to the heads of this taxon, which are noticeably smaller than those of *O. pimeleoides*, from which it has been segregated.

OTHER SPECIMENS EXAMINED: NEW SOUTH WALES: South Far Western Plains: Balranald, *T.P. Lucas 66*, 1878 (MEL, PERTH); Paika [Lake]–Balranald, *[T.P. Lucas] 66*, Aug 1878 (MEL); 28 km W of Euston, *W.E. Mulham s.n.*, Oct. 1978 (NSW). VICTORIA (selection from a total of 60): Melbourne: Brisbane Ranges, *J. Anderson 320*, Nov 1968 (AD, MEL). Mallee: Wentworth, *Mrs Farr s.n.*, – (MEL); 5 miles [8 km] E of Peebinga, *J.H. Willis s.n.*, Aug 1955 (MEL). South West: Mt Richmond National Park, *R.J. McHugh s.n.*, Mar 1975 (MEL). SOUTH AUSTRALIA (selection from a total of 226): Nullarbor: 4 miles [6 km] SW of Maralinga, *L.D. Williams s.n.*, Aug 1977 (AD). Murray: Pinnaroo, *J.B. Cleland s.n.*, Aug 1927 (AD). South Eastern: Biscuit Flat, Comaum, *C.R. Alcock 175*, Nov 1969 (AD). WESTERN AUSTRALIA: South-West Botanical Province: Roe District: Mt Ragged, *S.T. Brooks s.n.*, 1889 (MEL). Eremaean Botanical Province: Helms District: 2.4 km W of 'Nippon Junction', *D.J. Pearson 442*, June 1988 (PERTH). Eucla District: 'Eucla', *J. Richards s.n.*, 1877 (MEL); 100 miles [161 km] E of Madura Pass, s. coll., – (NSW 180795).

Olearia montana *Lander*, **sp. nov.**

Species nova *Olearia stellulatae* affinis sed flosculis numerosioribus radiatis (17–28 cf. 11–16) et discis (15–13 cf. 9–14) praeclare distinguitur.

TYPE: NEW SOUTH WALES: Southern Tablelands: Tinderry Mountains, *T.G. Hartley 13407*, October 1971 (holo CANB; iso CHR, K, NSW, PERTH).

Shrub to 2 m high. *Vestiture* of stems, abaxial surfaces of leaves and involucral bracts tomentose with multicellular, stellate hairs. *Stems* ascending, smooth, yellowish brown becoming greyish brown, striate. *Leaves* alternate, scattered, divergent, petiolate; petiole stout, to 5 mm long; lamina flat, elliptic, 13–43 x 7–18 mm, discolorous, green and subglabrous adaxially, pale-brown-tomentose abaxially; texture subcoriaceous; venation distinct, reticulate; base obtuse or rounded; margin serrate, flat; apex obtuse, muticous. *Heads* in paniculate conflorescences, pedunculate, radiate, 18–27 mm diam.; disc 6–9 mm diam. *Peduncle* to 15 mm long, with several leaf-like bracts grading into those of the involucre. *Involucre* hemispheric; bracts 3–4-seriate, 4.2–6.6 x 0.9–2.0 mm. *Outer involucral bracts* triangular, flat; stereome yellowish brown, uniformly densely stellate-tomentose, with uniseriate, capitate glandular hairs scattered basally; margin chartaceous, purple, ciliate; apex acute. *Inner involucral bracts* narrowly linear or triangular, flat; stereome pale green, densely stellate-tomentose centrally to apically, with scattered glandular hairs centrally; margin membranous, entire, fimbriate apically; apex acute. *Receptacle* convex. *Marginal florets* 17–28, female, uniseriate; corolla radiate, 9.5–12.8 mm long; tube with stellate hairs and multicellular, biseriate, simple, eglandular hairs scattered centrally to apically; ligule narrowly elliptic, 6–9 x 1.8–2.8 mm, mauve, glabrous; apex minutely 2-lobed; stylar arms narrowly filiform, 1.3–1.8 mm long. *Disc florets* 15–31, bisexual; corolla infundibular, 5.3–7 mm long, purple, with multicellular, uniseriate, simple, eglandular hairs scattered centrally-apically; lobes 5, narrowly triangular, 1.1–1.6 mm long; anthers 2–2.3 mm long, sagittate and shorter than the filament collar basally, with triangular terminal appendages; filament collar 0.3–0.4 mm long; stylar arms 1–1.9 mm long, with half-conic apical appendages bearing botuliform papillae. *Achene* narrowly obovoid, flattened, 1.3–2.4 x 0.5–0.8 mm, dark brown, glabrous, 6-ribbed; base acute with conspicuous, oblique carpopodium. *Pappus* multiseriate; bristles 35–71, minutely barbellate, subequal to the disc corolla, with an outer series of 10–35 shorter bristles. Figure 7.

DISTRIBUTION: Occurs in the Tinderry Range, Brindabella Range and Scabby Range on the Southern Tablelands of New South Wales (Figure 4).

HABITAT: In dry shallow soils over granite, on rocky slopes amongst sclerophyll forest and *Eucalyptus rossii* woodland.

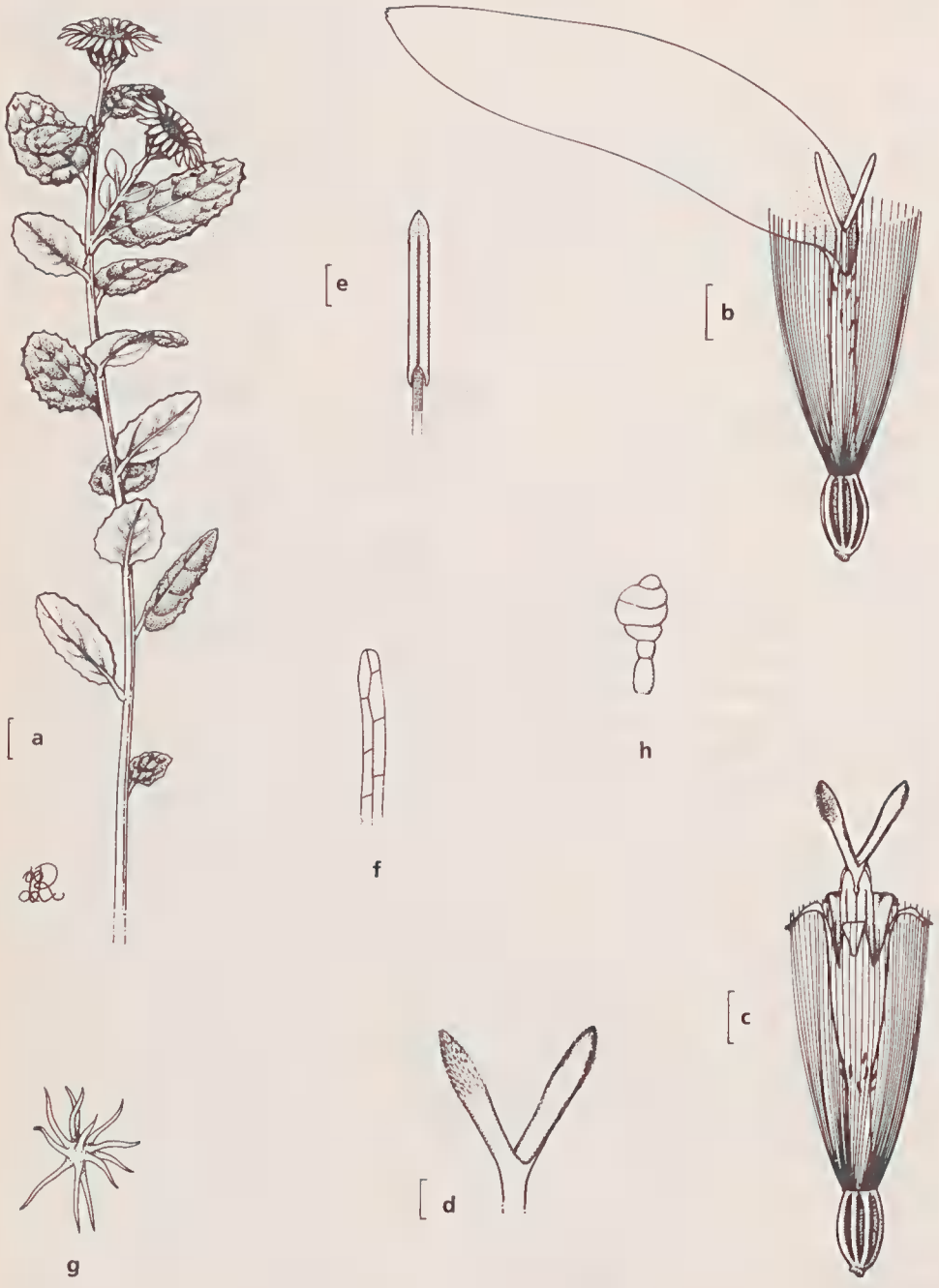

Figure 7. *Olearia montana*. **a,** habit. **b,** marginal floret. **c,** disc floret. **d,** stylar arms (from disc floret); **e,** anther. **f,** multicellular, uniseriate, capitate, glandular hair (from outer involucral bract). **g,** multicellular, biseriate, simple, eglandular hair (from disc floret). **h.** multicellular, stellate, eglandular hair (from leaf). From *T.G. Hartley 13407* (holo CANB). Scale bars: a = 1 cm; b, c = 1 mm; d,e = 0.5 mm.

Flowering period: September to October.

Affinities: The presence of stellate hairs on the vegetative parts of *Olearia montana* is typical of *Olearia* sect. *Asterotriche* where this species would seem best placed. Its affinities appear to lie with *O. stellulata*, from which it is readily distinguished: the heads of *O. stellulata* have 11–16 ray florets and 9–14 disc florets. The widespread *O. stellulata* is found on the North, Central and South Coast and Tablelands of New South Wales, and in the Victorian and Tasmanian Alps.

Notes: This is the species referred to as '*Olearia* sp. 2' by Briggs & Leigh (1988).

Conservation status: This species has a maximum geographic range of about 135 km and field notes indicate that it is rare. It was last collected in 1975. Briggs & Leigh (1988) note its occurrence in Namadgi National Park (Brindabella Range, 35°27' S, 148°46' E), Scabby Range Nature Reserve (34°45' S, 148°52' E) and Tinderry Nature Reserve; they give it the category 2RC. In view of the fact that its geographic range actually exceeds 100 km this should now be corrected to 3RC.

Etymology: The specific epithet refers to the montane habit of this species.

Other specimens examined: New South Wales: Southern Tablelands: summit of Tinderry Mt, *L. Costerman s.n.*, Jan 1975 (NSW 181855); 13.7 km ESE of Michelago, Tinderry Mts, *R.G. Coveny 6347*, Sep 1967 (NSW); 6 miles [9.6 km] E of Michelago on Jerangle Road, Tinderry Mts, *M. Evans 2620*, Sep 1967 (CANB, CHR, K, L, NSW); Tinderry Gap, *T. & S. Whaite 3132*, Oct 1966 (NSW); Tinderry Range, *Walker ANU 1189*, Oct 1963 (CANB).

Olearia oppositifolia *(F. Muell.) Lander*, **comb. nov.**

Basionym: *Eurybia oppositifolia* F. Muell. (1860a: 88-89).

Type citation: 'Ad Ripas rupestres torrentium montis Guy Fox Peak, ad flumen Anne et in monte Mitchell, altitudine 3000-4000'. Dr. Beckler.'

Syntypes: New South Wales: Northern Tablelands: River Ann, [*H. Beckler s.n.*], – (MEL 36433); on the rocky banks of the rivers Sarah and Anne, [collector illegible], – (MEL 36434).

Misapplied names: *Olearia chrysophylla* auct. non (DC.) Benth.: Bentham (1867: 468), p.p.; C. Moore (1884: 33), p.p.; Maiden & Betche (1916: 193), p.p. *Aster chrysophyllus* auct. non (DC.) A. Cunn. ex C. Moore: Moore (1893: 267), p.p.

Shrub to 2.3 m. *Vestiture* of stems, abaxial surfaces of leaves and involucral bracts of multicellular, divaricately forked (T-shaped), eglandular hairs and multicellular, biseriate, capitate glandular hairs. *Stems* ascending; bark smooth, pale brown, grey when mature. *Leaves* opposite, scattered, inclined, petiolate; petiole to 12 mm long; lamina flat, ovate or elliptic, 14–110 x 6–39 mm, discolorous, green and glabrous or subglabrous adaxially, pale-brown-, rarely purple-sericeous abaxially; texture coriaceous; venation distinct, pinnate/reticulate; base narrowly to broadly acute, obtuse or rounded; margin denticulate, sometimes entire or sinuate when young, flat or weakly revolute; apex acute or rounded, mucronulate. *Heads* in terminal, compound-corymbose conflorescences, pedunculate, radiate, 18.6–22.8 mm diam.; disc 4–7 mm diam. *Peduncles* to 50 mm long, with or without several leaf-like bracts grading into those of the involucre. Involucre conic to narrowly conic; bracts 3–4-seriate, 2.5–6 x 1–1.6 mm. *Outer involucral bracts* ovate, cymbiform; stereome pale green, uniformly densely sericeous; margin membranous, with scattered multicellular, biseriate, capitate, glandular hairs, fimbriate; apex narrowly rounded. *Inner involucral bracts* narrowly ovate, somewhat cymbiform; stereome pale green, uniformly weakly sericeous; margin membranous, with scattered glandular hairs; apex rounded. *Receptacle* strongly con-

Figure 8. *Olearia oppositifolia*. **a,** habit; **b,** marginal floret. **c,** disc floret; **d,** stylar arms (from disc floret); **e,** anther; **f,** multicellular, divaricately forked (T-shaped), eglandular hair (from leaf). From *J.L. Boorman s.n.* (NSW 127485). Scale bars: a = 1 cm; b, c = 1 mm; d, e = 0.5 mm.

vex. *Marginal florets* 4–6, female, uniseriate; corolla radiate, 11.4–13 mm long; tube glabrous; ligule, narrowly elliptic, 8–9 x 1.8–2 mm, white, glabrous; apex minutely 3-lobed; stylar arms filiform, 1.1–1.4 mm long. *Disc florets* 6–11, bisexual; corolla infundibular, 6–7 mm long, yellow, glabrous; lobes 5, triangular, 1.5–1.9 mm long; anthers 2.2–2.5 mm long, narrowly acute (rarely caudate) and shorter than the filament collar basally, with narrowly elliptic or narrowly ovate terminal appendages; filament collar 0.4–0.7 mm long; stylar arms 1.2–1.9 x 0.2–0.3 mm, with half-ovoid apical appendages bearing botuliform papillae. *Achene* very narrowly obloid, 2.2–3 x 0.5–0.7 mm long, pale brown to brown, glabrous or subglabrous with duplex hairs scattered apically, distinctly 5–8-ribbed; base acute with conspicuous, central carpopodium. *Pappus* biseriate; bristles 44–77, subequal to the disc corolla with several shorter bristles. Figure 8.

Distribution: Restricted to the North Coast and Northern Tablelands of New South Wales (Figure 2).

Habitat: In wet and dry sclerophyll forests.

Flowering period: November to January.

Notes: This taxon was synonymised under *Olearia chrysophylla* by Bentham (1867: 468) and subsequent authors. It is the undescribed species referred to by Beadle (1980: 636).

Affinities: The multicellular, divaricately branched (T-shaped) eglandular hairs on the vegetative surfaces of *Olearia chrysophylla* are typical of *Olearia* sect. *Dicerotriche* where this species would seem best retained. Its affinities appear to lie with *O. chrysophylla*, from which it is readily distinguished: the leaf margins of *O. chrysophylla* are entire, only sometimes sinuous or indistinctly and irregularly denticulate; its heads are 21.6–27.6 mm diam. with 12–14 disc florets; its pappus comprises 73–85 bristles. *O. oppositifolia* and *chrysophylla* are geographically disjunct: the latter is restricted to the Central Coast and Central Tablelands of New South Wales.

Conservation status: This species is widely distributed in areas unlikely to experience any change in land use, occurs in National Parks and is well collected. It is considered neither rare nor endangered.

Etymology: The specific epithet refers to the opposite leaves of this taxon.

Other specimens examined (selection from a total of 59): New South Wales: North Coast: Drake, *J.L. Boorman s.n.*, Oct 1901 (AD, NSW 127485). Northern Tablelands: Gloucester Tops, *R.G. Coveny s.n.*, Jan 1966 (NSW, PERTH); 19.2 miles [31 km] E of Glen Innes on Grafton Road, *M. Gray 3005b*, Dec 1953 (CANB, NSW); 20 km E of Ebor, *N.S. Lander 514*. Oct 1974 (NSW); Gibraltar Range National Park, *N.S. Lander 533*, Oct 1974 (NSW); 1 mile [1.6 km] S of Point Lookout, *J.B. Williams s.n.*, Dec 1966 (NE – n.v., NSW).

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References

Bentham, G. (1867) *Flora Australiensis*, vol. 3. (Lovell Reeve & Co.: London).

Beadle, N.C.W. (1980) *Students flora of north-eastern New South Wales*, vol. 4. (University of New England: Armidale).

Black, J.M. (1965) *Flora of South Australia*, edn 2, vol. 4. (Government Printer: Adelaide.).

Briggs, J. & J. Leigh (1988) *Rare or threatened Australian plants*, revised edition. Australian National Parks and Wildlife Service: Canberra, Special Publication 14.

Ewart, A.J. (1931) *Flora of Victoria*. (Government Printer: Melbourne).

Jessop, J.P. (ed.) (1967) *Vascular plants of South Australia*, edn 2 (Government Printer: Adelaide).

Jessop, J.P. & H.R. Toelken (eds) (1986) *Flora of South Australia*, edn 2. (Government Printer: Adelaide).

Maiden, J.H. & E. Betche (1899) Notes from the Botanic Gardens, Sydney No. 4. *Proc. Linn. Soc. New South Wales* 24: 143-153.

Maiden, J.H. & E. Betche (1916) *A census of New South Wales plants*. (Government Printer: Sydney).

Moore, C. (1884) *A census of the plants of New South Wales*. (Government Printer: Sydney).

Moore, C. (1893) *Handbook of the flora of New South Wales*. (Government Printer: Sydney).

Mueller, F. (1860a) *Fragmenta phytographiae Australiae* 2.

Mueller, F. (1860b) On two alpine *Eurybiae* of the Australian continent. *Papers & procedings of the Royal Society of Van Diemen's Land* 3: 227-230.

Radford, A.E. (1986) *Fundamentals of plant systematics*. (Harper & Row: New York).

Wakefield, N.A. (1956) Flora of Victoria: new species and other additions — 10. *Victorian Naturalist* 73: 96-97.

Willis, J.H. (1973) *A handbook to plants in Victoria*, vol. 2. (Melbourne University Press: Melbourne).

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Synonymy and chemotaxonomy of Australian *Pertusaria* species (Lichenes) based on Australian type specimens

Alan W. Archer

Abstract

Archer, Alan W. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. Synonymy and chemotaxonomy of Australian Pertusaria *species (Lichenes) based on Australian type specimens.* Telopea *4(2): 165-184.* The type specimens of 44 Australian taxa and several non-Australian taxa in the genus *Pertusaria* were examined; 17 of these names are synonyms for previously described taxa. *P. melaleuca* var. *trispora* Müll. Arg. is a synonym of *P. pustulata* var. *trimera* Müll. Arg., which is raised to species level as *P. trimera* (Müll. Arg.) A. Archer, comb. nov. The remaining 28 names are accepted as legitimate. Lectotypes are selected for *P. communis* var. *neo-caledonica* Nyl., *P. confluens* Müll. Arg., *P. irregularis* Müll. Arg., *P. meridionalis* var. *xanthostoma* Müll. Arg., *P. microsporella* Zahlbr. and *P. rhodotropa* Müll. Arg. The chemistry of the specimens examined is reported.

Introduction

Between 1882 and 1895 J. Müller (Müll. Arg.) described 39 new taxa in the genus *Pertusaria*, based on specimens collected in Australia (J. Müller 1882a, 1883, 1884, 1891a, 1893a, 1893b, 1895a, 1895b). Additional taxa in the genus were described by G. Körber (1862) and C. Knight (1882, Shirley 1889) giving a total of 44 taxa based on Australian type material. The type specimens of these taxa have received little study apart from nomenclatural changes by Zahlbruckner (1928) to remove synonyms, and listing for the Index to Type Specimens of Australian Lichens (Filson 1986). This note reports the results of a chemotaxonomic examination of the type specimens of the 44 Australian taxa and relevant non-Australian taxa, and more recent collections of the same taxa. An index of all taxa mentioned is included. No key is included in this account as several new species have been found; these, together with a key to the genus in Australia, will be published at a later date.

Material and methods

The material examined consisted of type specimens from BRI, G, W, WELT and WRSL, and additional specimens from AD, ANUC, BRIU, CBG, GZU, H, HO, MEL, NSW and PERTH and from the herbaria of J.A. Elix, W.H. Ewers, J. Hafellner, K. Kalb, G. Kantvilas, H.T. Lumbsch, H. Mayrhofer, R.W. Rogers, G.N. Stevens, H. Streimann and D. Verdon. All types cited here have been examined unless otherwise indicated.

Slices of verrucae were mounted in water for measurement of spore size; the spore descriptions follow the nomenclature of Dibben (1980: 10).

Thin-layer chromatography was carried out on acetone extracts using the mobile phases A and C of Culberson (1972) and the compounds were detected with UV light, sulphuric acid (Culberson 1972) and MBTH (Archer 1978). Perlatolic acid and

its derivatives were separated using an alkaline mobile phase (Archer 1987) and differentiated with MBTH. The unidentified compound UN1 (Dibben 1980: 13), which was found in some Australian specimens, corresponds to the unidentified depside mH examined by Hanko (Hanko 1983: 50).

Results

1. Pertusaria aberrans *Müll. Arg.*
(Müller 1893a: 42).

TYPE: VICTORIA: Loughton Gully, Lakes Entrance, *F.R.M. Wilson 1517*, Mar 1889; holo G; iso NSW.

Thallus off-white to pale greyish white, coarsely areolate and cracked, surface smooth and slightly shiny, corticolous; verrucae numerous, contiguous, almost completely covering the thallus surface, c. 1 mm wide, immersed, occasionally slightly raised above the surface, centre slightly depressed; ostioles 1 per verruca, black, conspicuous, 0.1–0.5 mm diam., becoming slightly sunken and disc-like; spores 2–4 per ascus, uniseriate, ellipsoid, smooth, 75–87µm long, 28–36 µm wide.

CHEMISTRY: stictic acid.

P. aberrans somewhat resembles *P. trypetheliiformis* (Nyl.) Nyl. (Nylander 1859) [Type: Tahiti, *Lepine 17*; holo H-NYL 23588] but is distinguished from that species by the smooth spores, whereas they are rough in *P. trypetheliiformis*. *P. aberrans* is known only from the type specimen.

2. Pertusaria concava *Müll. Arg.*
(Müller 1895a: 640)

TYPE: VICTORIA: The Grampians, *Sullivan s.n.*, 1894 ; holo G.

Thallus off-white to pale greyish white, cracked and areolate, surface smooth and dull, saxicolous; apothecia disciform, abundant, conspicuous, 0.3–0.7 mm diam., the margins concolorous with the thallus, discs black, 0.1–0.4 mm diam.; spores 6–8 per ascus, uniseriate, ellipsoid, smooth, 30–45 µm long, 17–25 µm wide.

CHEMISTRY: K+ red, KC-, C-, Pd + yellow; norstictic acid.

P. concava resembles two saxicolous *Pertusaria* species from New Zealand, *P. erumpescens* Nyl. and *P. perfida* Nyl. The three taxa have 8-spored asci with similar spores and contain norstictic acid but *P. erumpescens* has verrucae with ostioles and *P. perfida* has 1–3 discs per verruca in contrast to the single disc in *P. concava*. Both New Zealand taxa are reported to be endemic (Galloway 1985).

P. concava is distinguished from the morphologically similar Australian *P. paratropa* Müll. Arg. (q.v.) by the presence of norstictic acid.

ALSO EXAMINED: NEW SOUTH WALES : Jenolan Caves, *Wilson s.n.*, Sep 1897 (NSW L4581); Tinderry Mtns, 11 km ESE of Michelago, *Verdon 2070*, Jan 1976 (CBG 8403934). VICTORIA: Lookout Hill, 1.5 km E of Myrtleford, *Streimann 35931*, Dec 1985 (CBG 9003890 p.p., H); Trentham Falls, c. 20 km E of Daylesford, *Hafellner 15752a*, July 1986 (GZU).

3. Pertusaria confluens *Müll. Arg.*
(Müller 1895a: 638).

LECTOTYPE (here selected): QUEENSLAND: Toowoomba, *Hartmann s.n.*, 1894; lecto G; residual syntype: G.

Thallus dull yellow, thin, somewhat wrinkled and folded, surface smooth and dull, corticolous; verrucae numerous, scattered, somewhat elongated hemispherical, occasionally confluent, not constricted at the base, 0.5–1 mm wide; ostioles inconspicuous, dark, 1–3 per verruca; spores 4–8 per ascus, irregularly uniseriate, ellipsoid to slightly fusiform, smooth, 48–55 µm long, 23–28 µm wide.

CHEMISTRY: K+ weak yellow, KC-, C-, Pd-; thiophaninic and stictic acids with traces of constictic and hypoconstictic acids.

When Müller described *P. confluens* he cited two specimens from Queensland collected respectively by Hartmann and Knight; the specimen collected by Hartmann is the only specimen with a written reference to the publication 'Lecan. & Lecid. Aust. n. 26' [Lecanoreae et Lecideeae Australienses novae, species number 26 (Müller 1895a)] and this specimen is therefore chosen as lectotype.

ALSO EXAMINED: QUEENSLAND: Weyba Creek, c. 70 km SE of Gympie, on mangrove, *Hafellner 17992*, July 1986 (GZU).

4. Pertusaria crassilabra *Müll. Arg.*
(Müller 1893b: 126).

TYPE: VICTORIA: Loutit Bay [near Lorne], *Luehmann s.n.*, 1891; holo G.

Thallus thick, off-white, somewhat granular, minutely cracked and areolate, surface smooth and dull, saxicolous; verrucae conspicuous, scattered, immersed or flattened hemispherical, with constricted bases, 0.5–1.5 mm diam., the centre often depressed; ostioles conspicuous, large, black, 1 per verruca, 0.2–0.5 mm diam.; spores 8 per ascus, irregularly biseriate, ellipsoid, smooth, 65–72 µm long, 30–32 µm wide.

CHEMISTRY: K, KC, C, Pd -; orthothelin (2, 4, 5-trichloro-norlichexanthone) and a second minor unidentified compound, blue fluorescence, Rf 14 (C), 10 (A), no colour with sulphuric acid.

P. crassilabra is known only from the type specimen.

5. Pertusaria elliptica *Müll. Arg.*
(Müller 1895a: 635).

TYPE: QUEENSLAND: [Goodna, fide Shirley (1896)], *Shirley 1754 p.p.*, 1893; holo G.

Thallus off-white or pale grey to pale olive green, thin, surface smooth or slightly rough and dull, corticolous; verrucae conspicuous (but less conspicuous on rough substrates), scattered, slightly flattened hemispherical, rounded or elongated or irregular in outline, sometimes becoming constricted at the base and sometimes concave on top, 0.5–1.5 mm wide; ostioles conspicuous, black, 1 or 2 per verruca; spores 3 to 4 per ascus, uniseriate, elongate-ellipsoid to subfusiform, rough, 80–112(–125) µm long, 30–42 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; 4,5-dichlorolichexanthone, 2-O-methylperlatolic acid and 2'-O-methylperlatolic acid.

P. elliptica is characterised by the four rough spores per ascus and differentiated from the similar *P. leucothelia* by the presence of the isomeric O-methylperlatolic acids. It occurs on mangroves and other unspecified trees in eastern Queensland, New South Wales and New Caledonia.

ALSO EXAMINED (7 out of 28): QUEENSLAND: Whitsunday Island, Whitehaven Beach, *Gilbert*, Aug 1974 (HO 50948); Hook Island [E of Proserpine], *Gilbert*, – (HO 50943); Port Alma, *Rogers 708*, June 1975 (BRIU); Glasshouse Mtns, S of Tibrogargan Creek, *Hafellner 19454*, Aug 1986. NEW

South Wales: Hastings Point, Cudgera Creek, *Stevens 1933*, Aug 1975 (BRIU). Australian Capital Territory: Cotter Caves, 20 km W of Canberra, on *Casuarina*, *Elix 9075*, June 1981 (ANUC). New Caledonia: Nouméa, *Wilson s.n.*, July 1891 (H).

6. Pertusaria erythrella *Müll. Arg.*
(Müller 1893a: 41).

Type: Victoria: Lakes Entrance, *F.R.M. Wilson 999*, 1891; holo G.

Thallus off-white to pale greyish white, slightly cracked and areolate, surface slightly wrinkled and dull, sorediate, corticolous; soralia white, numerous, conspicuous, disc-like or sub-hemispherical, sometimes constricted at the base, 0.5–1 mm diam., upper surface sometimes becoming smooth and pale reddish brown; asci and spores not seen.

Chemistry: K+ yellow-orange, KC-, C-, Pd+ yellow; norstictic acid with stictic acid (tr), with or without lichexanthone.

Also examined: Queensland: Gambubal State Forest, Bald Mtn, *Hafellner 16340*, Sep 1986 (GZU). New South Wales: Dural Extension of Cumberland State Forest, c. 4 km S of Dural, *Archer P97*, Mar 1990 (NSW); Stanwell Park, *Cheel s.n.*, Aug 1902 (NSW L4526); Fitzroy Falls, 16 km SE of Moss Vale, *Verdon 3030*, Aug 1977 (CBG 7802735); Reedy Creek, Marble Arch, 48 km S of Braidwood, *Elix 4428*, Mar 1978; Currawon State Forest, 14 km NW of Batemans Bay, *Streimann 27689*, May 1987 (CBG 830945). Tasmania: Deal Island, Kents Group, Bass Strait, *Whinray s.n.*, Dec 1970 (MEL 1012473).

P. erythrella resembles corticolous *P. paeminosa* (q.v.) but is distinguished from that species by the presence of norstictic acid.

7. Pertusaria gibberosa *Müll. Arg.*
(Müller 1882a: 486).

Type: Tasmania: s. loc., *F. Müller s.n.*, 1882; holo G.

Pertusaria virginea Müll. Arg. (Müller 1882a: 486). Type: New South Wales: Parramatta, *Woolls s.n.*, 1879; holo G.

Pertusaria moffatiana Müll. Arg. (Müller 1883: 79). Type: Victoria: Mount Macedon, *Moffat s.n.*, 1882; holo G.

Pertusaria nitidula Müll. Arg. (Müller 1893a: 42). Type: Victoria: s. loc., *F.R.M. Wilson 468 p.p.*, 1891; holo G.

Pertusaria graphidioides Müll. Arg. (Müller 1893a: 42). Type: Victoria: Doncaster, *F.R.M. Wilson 492*, 1892; holo G.

Pertusaria microsporella Zahlbr. (Zahlbruckner 1928: 180); *Pertusaria microspora* Müll. Arg. (Müller 1895a: 637); nom. illeg. non *P. microspora* Krempelh. 1876. Lectotype (here selected): Victoria: Loutit Bay, *Luehmann s.n.*; lecto G; residual syntype G.

Thallus variable, thick and continuous to thin and discontinuous, off-white or greyish-white to yellowish white, slightly cracked and areolate, surface smooth or slightly wrinkled, dull, corticolous; verrucae conspicuous, numerous to scattered, occasionally confluent, hemispherical or slightly or conspicuously flattened hemispherical with irregular outline, becoming constricted at the base, 0.5–1.5 mm wide; ostioles pale brown to black, usually conspicuous, sometimes sunken, rarely raised, 1 to 8 per verruca; spores 8 per ascus, uniseriate, ellipsoid, smooth, 32–65(–70) µm long, 15–30 µm wide.

Chemistry: K-, KC-, C-, Pd-; 4,5-dichlorolichexanthone, 2'-O-methylperlatolic acid and anzaic acid (tr).

P. gibberosa is characterised by the white to grey-white thallus, the negative chemical reactions and, in particular, the usually abundant asci, each containing eight uniseriate spores.

The species is widely distributed across Australia and is common in south-eastern mainland Australia and Tasmania; it grows on *Acacia, Banksia, Bedfordia, Casuarina, Ceratopetalum, Cyathodes, Exocarpos, Pomaderris* and other unspecified trees, from sea-level to c. 1100 m. It is doubtfully distinguished from the similar *P. woollsiana* Müll. Arg. (q.v.) only by the different chemistry.

Older herbarium specimens of *P. gibberosa* were often identified as *P. anarithmetica* Müll. Arg. from Costa Rica (Müller 1891b), but examination of one of the two syntypes [Costa Rica, San Jose, *Pettier 5262*, 1890; G] showed that the spores are biseriate and 2'-O-methyl perlatolic acid is absent. *P. anarithmetica* was reported to occur in Australia (Müller 1893a) but the specimen on which this report was based ['Doncaster, *Wilson n.470*' (NSW L4616)] is *P. gibberosa*. *P. communis* DC. was reported from Victoria (Wilson 1887) but this specimen, from Camperdown (NSW L4434), is also *P. gibberosa*.

The type specimens of *P. gibberosa*, *P. virginea* and *P. nitidula* are indistinguishable; the type specimen of *P. moffatiana* has slightly flattened verrucae but is otherwise identical with *P. gibberosa* and the type specimen of *P. graphidioides* has somewhat larger ostioles. *P. 'microspora'* was separated as a species by the smaller spores, reported by Müller as 30–35 µm long and 15–19 µm wide but in the lectotype the spores were 40–50 µm long and 20–25 µm wide, similar to those of *P. gibberosa*. Müller himself referred to similarities with *P. gibberosa* and *P. nitidula* in the protologue to *P. 'microspora'*. The chemistry of all the type specimens is identical.

In the protologue to *P. 'microspora'* Müller cited specimens from Loutit Bay, Mt Erica, Upper Yarra and Mt Mueller; the specimen from Loutit Bay was chosen and annotated as lectotype by R. Filson in 1971 and this specimen is selected here.

The earliest name for *P. gibberosa* may be *P. pertractata* Stirton (Stirton 1876) but the holotype of this taxon, from Tasmania, was not available for study. A recent examination of this material found similarities with *P. gibberosa* but the specimen was too small for a definite conclusion to be reached (G. Kantvilas, in litt.).

Also examined (8 out of 85): Queensland: Brisbane, Chermside, *Rogers 4077*, Aug 1977 (BRIU); Bunya Mtns, Mt Mowbullan, *Kalb 20404*, Aug 1988 (herb. KALB). New South Wales: Jenolan Caves, *Wilson s.n.*, Sep 1897 (NSW L4577). Australian Capital Territory: Condor Creek, c. 25 km W of Canberra, *Mayrhofer 5338*, Sep 1981 (GZU). Victoria: Mt William summit, *Archer P76*, Oct 1989 (NSW). Tasmania: Raoul Lookout, Tasman Peninsula, *Kantvilas 617/80*, Nov 1980 (HO). South Australia: Bangham Scrub, 14 km N of Francis, *Munir 5553E*, Nov 1981 (AD 20140). Western Australia: Ravensthorpe, *Bratt 67/312* (H0 51083).

8. Pertusaria hartmannii *Müll. Arg.*
(Müller 1882a: 485).

Pertusaria trypetheliiformis (Nyl.) Nyl. var. *hartmannii* (Müll. Arg.) Müll. Arg. (Müller 1884: 351). Type: Queensland: Toowoomba, *Hartmann s.n.*; holo G.

Pertusaria muelleriana Zahlbr. (Zahlbruckner 1928: 181); *Pertusaria albinea* Müll. Arg. (Müller 1895a: 635); nom. illeg. non Tuckerman 1877. Type: Queensland: [Goodna, fide Shirley (1896)], *Shirley 1754 p.p.*, 1893; holo G.

Thallus thin, pale greyish white to dull greenish white, continuous or slightly cracked, surface smooth to slightly wrinkled, dull, corticolous; verrucae conspicuous, scattered, occasionally confluent, slightly flattened, hemispherical or irregular in outline,

becoming constricted at the base, 0.5–1.5(–2.5) mm wide; ostioles conspicuous, black, 1 to 8 per verruca; spores 2 per ascus, uniseriate, elongate-ellipsoid, smooth, 120–170(–200) µm long, 35–60 µm wide.

CHEMISTRY: K+ red, KC-, C-, Pd+ yellow; norstictic and perlatolic acids, with or without lichexanthone (tr).

P. hartmannii is found in eastern Queensland where it grows on mangroves and other unspecified trees. Specific status as *P. hartmanii* is appropriate for this taxon as it is chemically and morphologically distinct from *P. trypetheliiformis*.

P. hartmannii is chemically and morphologically similar to the two-spored *P. subobductans* Nyl., described from Japan (Nylander 1890) but an examination of the lectotype of this taxon [Japan, Murayama, *E. Almquist s.n.*, 1879; lecto H. Kashiwadani 1975, H-NYL 23264] showed it to possess larger, flattened verrucae, inconspicuous pale ostioles and smaller spores.

P. hartmannii is characterised by the presence of norstictic and perlatolic acids and by having two large, smooth spores per ascus.

ALSO EXAMINED: QUEENSLAND: Tingalpa Creek, *Wilson*, Aug 1896 (NSW L4640); Weyba Creek, SW of Noosa Heads, *Stevens 2373*, Dec 1975 (BRIU); Mt Fox, 43 km SW of Ingham, *Elix 20365*, June 1986 (ANUC); Noosa River, 70 km S of Gympie, *Hafellner 19212*, July 1986 (GZU); Tandora, c. 25 km ENE of Maryborough, *Hafellner 18278*, Aug 1986 (GZU).

9. Pertusaria irregularis *Müll. Arg.*
(Müller 1895a: 638).

LECTOTYPE (here selected): QUEENSLAND: Thursday Island, *Knight 31 p.p.*; lecto G; residual syntype: Queensland: Thursday Island, *Knight 41 p.p.*; G.

[non *P. irregularis* Magn. (Magnusson 1955)]

Thallus pale yellowish white, thick, coarsely cracked and areolate, surface smooth and dull, corticolous; verrucae inconspicuous, flattened hemispherical, not constricted at the base, c. 1 mm wide; ostioles conspicuous, black, 1 to 3 per verruca; spores 2 per ascus, irregularly uniseriate, fusiform, smooth, (120–)130–155 µm long, 35–47 µm wide.

CHEMISTRY: 4,5-dichlorolichexanthone.

P. irregularis is known only from the type specimens.

When J. Müller described *P. irregularis* he cited two specimens from Thursday Island collected by Knight, viz 31 p.p. and 41 p.p.; the specimen labelled '31 pr.p.' is the only specimen with a written reference to the publication, 'Lecan. & Lecid. n. 24' [Lecanoreae et Lecideeae Australienses, species number 24 (Müller 1895a)] and is therefore chosen as lectotype. A third specimen from G, labelled 'Thursday Is. N. Queensland Knight 1887' has no collector's number and has 8 spores per ascus; it is not *P. irregularis*.

P. irregularis is characterised by the two large, fusiform spores per ascus.

10. Pertusaria leiocarpella *Müll. Arg.*
(Müller 1895a: 636).

TYPE: QUEENSLAND: s.loc., *Knight 11*, 1887; holo G.

Thallus pale yellowish grey to pale greenish grey, minutely cracked and areolate, surface wrinkled and dull, corticolous; verrucae conspicuous, scattered, 0.4–0.8 mm

diam., flattened hemispherical, often irregular in outline, slightly constricted at the base; ostioles inconspicuous, pale, translucent, 0.05–0.4 mm diam., becoming dark at the centre, 1 per verruca; spores 8 per ascus, irregularly uniseriate to biseriate, ellipsoid, smooth, 55–80 µm long, 25–35 µm wide.

CHEMISTRY: 4,5-dichlorolichexanthone, stictic acid and constictic acid (tr).

P. leiocarpella is characterised by the biseriate spores and translucent ostioles; it occurs in eastern Queensland where it grows on mangroves and other unspecified trees.

ALSO EXAMINED: QUEENSLAND: Keppel Sands, near Rockhampton, *Rogers 895*, June 1975 (BRIU); Kuranda Range, near Cairns, *Kalb 19810*, Aug 1988 (herb. KALB); Sunshine Coast, c. 100 km N of Brisbane, *Kalb 19761, 19768*, Sep 1988 (herb. KALB).

11. Pertusaria leucostigma *Müll. Arg.*
(Müller 1884: 462).

TYPE: QUEENSLAND: Cunninghams Gap, *Hartmann s.n.*, 1883; holo G.

Thallus pale olive-green, coarsely cracked and areolate, somewhat wrinkled, surface dull and minutely tuberculate, corticolous; verrucae conspicuous, scattered, rarely confluent, slightly flattened hemispherical, not constricted at the base, 1–1.5 mm diam.; ostioles inconspicuous, pale, becoming dark, 1 per verruca; spores 8 per ascus, irregularly uniseriate, subfusiform to ellipsoid, smooth, 75–105 µm long, 30–45 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; 2-O-methylperlatolic acid and lichexanthone.

P. leucostigma is characterised by the eight fusiform spores and the presence of 2-O-methylperlatolic acid. It grows on mangroves, eucalypts, *Nothofagus* and other unspecified trees in Queensland and New South Wales. It is distinguished from *P. subrigida* (q.v.), which also has 8 fusiform spores per ascus, by the presence of 2-O-methylperlatolic acid.

ALSO EXAMINED: QUEENSLAND: Natural Arch National Park, *Elix 1120*, Aug 1975 (ANUC); Brisbane, Deception Bay, *Lumbsch 5381i*, Aug 1987 (herb. LUMBSCH). NEW SOUTH WALES: Bundeena, Royal National Park, *Elix 2601*, Apr 1976 (ANUC); Blue Mountains, Glenbrook, Sassafras Gully, *Kalb 18872, 18873, 20513*, July 1988 (herb. KALB); Batemans Bay, Buckenbowra River, *Elix 10985*, May 1983, *Kalb 18224, 18907*, Aug 1988 (herb. KALB); 1 km W of Mt Banda Banda, *Kantvilas 500/88*, Aug 1988 (HO); Myall River State Forest, 15 km E of Stroud River, *Archer P112*, Apr 1990 (NSW).

12. Pertusaria leucostomoides *Zahlbr.*
(Zahlbruckner 1928: 172).

Pertusaria leucostoma Müll. Arg. (Müller 1895a: 636) nom. illeg. non *P. leucostoma* (Bernh.) Mass. TYPE: QUEENSLAND: Toowoomba, *Hartmann s.n.*, 1894; holo G.

Thallus off-white to pale olive-green, slightly cracked, surface smooth and dull, corticolous; verrucae conspicuous, scattered, slightly flattened hemispherical to subconical, rarely confluent, not constricted at the base, 0.4–0.8 mm diam.; ostioles conspicuous, white, 1 or rarely 2 per verruca; spores 4–8 per ascus, uniseriate, ellipsoid, smooth, 65–70 µm long, 25–32 µm wide.

CHEMISTRY: 4,5-dichlorolichexanthone, stictic and norstictic (tr) acids.

P. leucostomoides is morphologically and chemically similar to *P. leiocarpella* (q.v.) and is differentiated from that species by the arrangement of the spores in the ascus, and

the white ostioles, unique in Australian *Pertusaria*. The verrucae are conspicuous and Müller (loc. cit.) compared them to Egyptian pyramids. *P. leucostomoides* is known only from the type specimen.

13. Pertusaria leucothelia *Müll. Arg.*
(Müller 1895a: 637).

TYPE: VICTORIA: s. loc., *Knight 147*, 1887; holo G.

Thallus dull greyish black, surface dull, corticolous; verrucae few, scattered, inconspicuous, 0.5–1 mm wide, iregularly hemispherical; ostioles inconspicuous, black, 1 or 2 per verruca; spores 4 per ascus, uniseriate, ellipsoid, rough, 87–97 µm long, 35–42 µm wide.

CHEMISTRY: 4,5-dichlorolichexanthone and planaic acid.

The type specimen of *P. leucothelia* is too small for examination by thin-layer chromatography and is overgrown by two other crustose species; the chemistry reported above is based on that of the two additional specimens examined which are tentatively identified as *P. leucothelia*.

P. leucothelia is morphologically similar to *P. elliptica*; both have four rough, ellipsoid spores per ascus but the species are distinguished by the absence of 2'-O- or 2-O-methylperlatolic acids from *P. leucothelia*.

Further specimens are required to confirm the chemistry and status of *P. leucothelia*.

ALSO EXAMINED: NEW SOUTH WALES: Warrumbungles, *Ewers 3667*, July 1989 (herb. EWERS). AUSTRALIAN CAPITAL TERRITORY: Cotter Reserve, 20 km W of Canberra, 500 m, on *Casuarina*, *Mayrhofer 5545*, Sep 1981 (GZU).

14. Pertusaria leucoxantha *Müll. Arg.*
(Müller 1895a: 637).

TYPE: QUEENSLAND: Thursday Island, *Knight 280*, 1887; holo G.

Thallus dull pale yellow, thin, slightly cracked, surface smooth and shiny, esorediate, saxicolous; verrucae inconspicuous, scattered, somewhat flattened hemispherical, not constricted at the base, 0.5–1 mm diam.; ostioles inconspicuous, black, 1 or 2 per verruca; spores 8 per ascus, irregularly uniseriate, ellipsoid-fusiform, smooth, 70–82 µm long, 32–42 µm wide.

CHEMISTRY: thiophaninic acid, 2-O-methylperlatolic acid and lichexanthone (tr).

P. leucoxantha somewhat resembles *P. xanthoplaca* Müll. Arg. (q.v.) but is distinguished from that species by the fusiform spores, the lack of soredia and the presence of 2-O-methylperlatolic acid.

ALSO EXAMINED: QUEENSLAND: Glasshouse Mountains, c. 3 km S of Crookneck Mountain, on rhyolite outcrops, 100 m, *Hafellner 15802*, July 1986 (GZU).

15. Pertusaria lophocarpa *Körber*
(Körber 1862: 34).

TYPE: NOVAE HOLLANDIAE: s.loc. *Hochstetter s.n.*; holo WRSL.

Pertusaria glebosa Müll. Arg. (Müller 1882: 485). TYPE: VICTORIA: Grampians, *Sullivan 14*, – ; holo G.

Pertusaria diffracta Müll. Arg. (Müller 1893a: 43). TYPE: VICTORIA: Lorne, on sandstone rock by stream, *F.R.M. Wilson 1055*, May 1887; holo G; iso NSW L4436.

Pertusaria arenacea Müll. Arg. (Müller 1895a: 29). TYPE: VICTORIA: Lorne, on sandstone rock by stream, *F.R.M. Wilson 1056*, May 1887; holo G; iso NSW L4477.

Pertusaria superba Zahlbr. (Zahlbruckner 1941: 332). TYPE: NEW ZEALAND: Otago, Mt Maungatua, *J. Thomson ZA 287*, May 1934; holo W.

Thallus off-white to pale fawn, thin and effuse to thick, then becoming cracked and areolate, surface smooth and dull, saxicolous; verrucae sparse and scattered to numerous and crowded, rarely confluent, conspicuous or almost immersed, flattened irregularly hemispherical often with concave tops, often constricted at the base, 1–2 (sometimes to 3) mm wide; ostioles conspicuous, black, 1 to 5 per verruca, sometimes sunken; spores 6 to 8 per ascus, uniseriate, ellipsoid, smooth, 45–75 µm long, 25–40 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; 4,5-dichlorolichexanthone, 2'-O-methylperlatolic acid with or without planaic acid (tr) and anzaic acid (tr). New Zealand specimens may also contain confluentic acid as an additional major lichen acid, vide infra.

The type specimen of *P. lophocarpa* was collected by Hochstetter in Victoria (Filson 1986). Körber reported *P. lophocarpa* to contain four spores per ascus but the type specimen contains 4 to 8 spores per ascus.

P. lophocarpa occurs at all altitudes from sea level to 1460 m on coastal dolerite, basalt, sandstone and alpine Precambrian rock and is often conspicuous on exposed rocks. It occurs in Victoria, New South Wales, Tasmania and New Zealand and rarely in Queensland and South Australia.

P. lophocarpa superficially resembles the saxicolous New Zealand *P. subverrucosa* Nyl. but is distinguished from that taxon by the larger ostioles, the number of spores (2 per ascus in the New Zealand species) and the K- reaction (*P. subverrucosa* reacts K+ red due to the presence of norstictic acid).

ALSO EXAMINED (11 out of 47): QUEENSLAND: Kroombit Tops National Park, 2 km S of Forestry Barracks [near Bundaberg], *Rogers 7905*, Sep 1985 (BRIU). NEW SOUTH WALES: Lithgow, *Wilson s.n.*, Sep 1897 (NSW L4578, L4582); Big Badja Hill, 47 km NE of Cooma, *Verdon 3473*, Mar 1978 (CBG 8412495); Mt Kaputar Natl Park, West Kaputar Rocks, *Merrotsy 454*, Feb 1987 (BRIU). VICTORIA: Bogong High Plains, Basalt Hill, *Filson 9760*, Jan 1967 (MEL 1023586); Hanging Rock, c. 70 km NE of Melbourne, *Hafellner 15749*, July 1986 (GZU). TASMANIA: Mount Wellington, Gap Track, *Bratt 1506* (HO 51049); Little Muselroe Bay, *Moscal*, Sep 1983 (AD 20493, HO 68795). SOUTH AUSTRALIA: Mt Lofty Ranges, 4 km W of Carey Gully, *Elix 2819, 2839*, Dec 1976 (ANUC). NEW ZEALAND: Castle Rock, Port Hills, Christchurch, *Elix 6980)*, Feb 1980 (ANUC).

16. Pertusaria macra *Müll. Arg.*
(Müller 1895a: 639).

TYPE: QUEENSLAND: Thursday Island, *Knight 262*, 1887; holo G.

Thallus thin, grey, minutely cracked and areolate, surface smooth and dull, saxicolous; verrucae conspicuous, numerous, scattered, flattened hemispherical, or sometimes immersed, 0.3–0.5 mm diam.; ostioles conspicuous, black, sunken, disc-like, 1 per verruca, 0.2–0.4 mm diam.; spores 8 per ascus, irregularly biseriate, ellipsoid, smooth, 30–36 µm long, 17–20 µm wide.

CHEMISTRY: stictic acid.

P. macra was reported from Queensland by Shirley (1896). It resembles *P. concava* (q.v.) and *P. paratropa* (q.v.) but is distinguished from both species by the presence of stictic acid, and from *P. paratropa* by the smaller spores.

P. macra is known only from the type specimen.

17. Pertusaria meridionalis *Müll. Arg.* [var.] α **xanthostoma** *Müll. Arg.*
(Müller 1881: 516).

LECTOTYPE (here selected): BRAZIL: Sao Paulo, Faxina, *Puiggari 1221*, June 1880; lecto G; residual syntypes G.

Pertusaria amblygona Müll. Arg. (Müller 1895a: 638). TYPE: QUEENSLAND: Toowoomba, *Hartmann s.n.*, 1894; holo G.

Thallus off-white to pale yellowish grey, thin to thick, cracked or continuous, surface smooth and dull, corticolous; verrucae conspicuous, numerous, sometimes confluent, slightly flattened hemispherical, less conspicuous on rough substrates, 0.5–1(–1.5) mm wide; ostioles 1 per verruca, rarely 2, conspicuous, bright yellow, slightly convex, somewhat translucent, 0.3–0.4 mm diam., developing one or more yellow, mammiform projections, 0.05–0.15 mm diam.; spores 6 to 8 per ascus, irregularly uni- or biseriate, ellipsoid, smooth, 50–87 µm long, 22–37 µm wide.

CHEMISTRY: thiophaninic acid, stictic acid and depside UN1, with or without norstictic acid (tr).

When Müller described *Pertusaria meridionalis* var. *xanthostoma* he referred to three specimens from South America; the specimen labelled '1221, Faxina, San Paulo, Brazil, Jun. 80, Puiggari' is the only specimen with a written reference to the publication, 'L.B. 338' [Lichenologische Beiträge XIV, number (338 Müller 1881)] and is therefore chosen as lectotype.

P. meridionalis var. *xanthostoma* occurs mainly in eastern Queensland and New South Wales, also in the Northern Territory and on Flinders Island in Bass Strait; it also occurs in Vanuatu, New Caledonia, Fiji and Brazil. It grows on mangroves, *Leucopogon* and other unspecified trees. It was also reported from Brisbane (Müller 1891) and from Goodna (Shirley 1891). The variety is distinguished from all other Australian *Pertusaria* species by the bright yellow ostioles which also distinguish it from the chemically similar North American *P xanthodes* Müll. Arg., which has paler ostioles and two spores per ascus.

ALSO EXAMINED (11 out of 31): QUEENSLAND: Brampton Island, *Gilbert s.n.*, Aug 1972 (HO 50947); North Stradbroke Island near Myora Springs, *Stevens 568*, Feb 1975 (BRIU); Four Mile Creek, 6 km W of Cooktown, *Elix 17420*, July 1984 (ANUC). NEW SOUTH WALES: Park Beach, Coffs Harbour, *Elix 3427 p.p.*, June 1977 (ANUC); 6 km N of Glen Martin, S of Dungog, *Mayrhofer 8281*, Aug 1988 (GZU). TASMANIA: Bass Strait, Flinders Island, *Whinray s.n.*, Apr 1969 (MEL 1035537 p.p.). NORTHERN TERRITORY: Berry Springs [near Darwin], *Beauglehole s.n.*, July 1965 (MEL 1028876 p.p.). VANUATU [as New Hebrides]: *Wilson s.n.*, 1895 (NSW L4654). NEW CALEDONIA: Nouméa, *Wilson s.n.*, July 1891 (H). FIJI: Amba, *Wilson s.n.*, Mar 1892 (H).

18. Pertusaria paeminosa *A. Archer*
(A. Archer 1990: 395).

TYPE: NEW SOUTH WALES: on exposed sandstone, Bairne Track, c. 30 km N of Sydney, *A. Archer P 38*, 14 Jan 1989; holo NSW; iso CBG.

Pertusaria sorediata Knight in Shirley (Shirley 1889: 141); nom. illeg., non *Pertusaria sorediata* (Fr.) Fr. 1846. TYPE: QUEENSLAND: Moreton Bay, *J. Shirley 67*, – ; holo WELT.

Thallus off-white to greyish white, moderately thick, margin well-defined and not zoned, areolate and cracked, surface smooth, sorediate, lacking isidia, saxicolous and corticolous; soralia white, conspicuous, becoming numerous and often confluent away from the margin, subspherical or flattened, sometimes becoming slightly stipitate in saxicolous specimens, 0.5–1.5 mm wide; apothecia rare, only in saxicolous specimens, disciform, 1–3 discs per soralia, discs dark brown, white pruinose, 0.2–0.5 mm diam.,

becoming exposed in stipitate soralia; asci clavate, 170–200 µm long, 50–60 µm wide; spores solitary, elongate ellipsoid, rarely lachrymoid, sometimes curved, 120–160 µm long, 35–50 µm wide, spore wall 1 µm thick.

CHEMISTRY: K -ve or K+ weak yellow, or rarely violet or red; KC- or + violet; Pd -ve or Pd+ yellow; lichexanthone and thamnolic acid ± picrolichenic acid; rarely with additional norstictic acid in saxicolous and corticolous specimens or rarely with thamnolic acid replaced by hypothamnolic acid in saxicolous specimens.

P. paeminosa was originally reported to be sterile (Archer 1990) but a recent examination of additional specimens, from ANUC and MEL, found two fertile saxicolous specimens; no fertile corticolous specimens have so far been found. An amended description of *P. paeminosa* is given above.

P. paeminosa is a common, conspicuous white crustose lichen which may cover large areas on exposed sandstone and other rocks. It is often found with the saxicolous *P. persulphurata* Müll. Arg. (q.v.) The species appears to be restricted to the Great Divide and the coastal region in Eastern Australia. The corticolous form of *P. paeminosa* resembles *P. novaezelandiae* Szatala and *P. erythrella* Müll. Arg. (q.v.) but these taxa contain hypothamnolic and norstictic acids respectively in contrast to *P. paeminosa* which contains thamnolic acid. It grows on mangroves, *Callitris*, *Ficus* and other unspecified trees.

ALSO EXAMINED (11 out of 79): SAXICOLOUS: QUEENSLAND: tip of Cape York Peninsula, *Alice Filson s.n.*, July 1977 (MEL 1018913) [fertile]; Miami, South Nobby, *Rogers 2424*, Oct 1981 (BRIU); Mistake Mountains, near Doggs Falls, on basaltic rocks, *Lumbsch 5699b*, Sep 1987 (CBG, NSW, herb. LUMBSCH). NEW SOUTH WALES: Sydney, South Head, *Cheel s.n.*, May 1901 (NSW L4446); Currowan State Forest, 12 km W of Nelligen, *Elix 3579*, July 1977 (ANUC) [fertile]; Springwood, Sassafras Creek, 65 km W of Sydney, *Archer P17*, Aug 1988 (GZU, NSW). AUSTRALIAN CAPITAL TERRITORY: Gudgenby Gorge, 27 km S of Canberra, *Lumbsch 5629b*, Sep 1987 (CBG, herb. LUMBSCH, M, NSW). CORTICOLOUS: QUEENSLAND: Noosa, Weybar Creek, *Stevens 2375*, Dec 1975 (BRIU); Cribb Island, Serpentine Creek, *Stevens 1075*, Sep 1975 (BRIU). NEW SOUTH WALES: Springwood, Sassafras Creek, 65 km W of Sydney, *Archer P8*, July 1988 (NSW). AUSTRALIAN CAPITAL TERRITORY: Gudgenby Gorge, 27 km S of Canberra, *Lumbsch 5628f*, Sep 1987 (herb. LUMBSCH).

19. Pertusaria paratropa *Müll. Arg.*
(Müller 1895a: 639).

TYPE: VICTORIA: Lorne, on sandstone rock by stream, *F.R.M. Wilson 528*, May 1887; holo G; iso NSW L4497, NSW L4498.

Thallus grey, areolate and cracked, saxicolous; verrucae numerous, scattered, disc-like, almost immersed or less frequently raised and constricted at the base, 0.5–1 mm diam.; ostioles conspicuous, black, 1 per verruca, sunken in the verrucae; spores 8 per ascus, irregularly uniseriate to almost biseriate, ellipsoid, smooth, 37–55 µm long, 20–30 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; no compounds detected by thin-layer chromatography.

P. paratropa occurs in Queensland and Victoria. It resembles *P. macra* (q.v.) but has larger spores and lacks stictic acid. The almost biseriate spore arrangement and the lack of lichen compounds (detectable by thin-layer chromatography) characterise this taxon.

ALSO EXAMINED: QUEENSLAND: Cunninghams Gap National Park, Mt Cordeaux, on basaltic rock, *Hafellner 15367*, Sep 1986 (GZU). VICTORIA: Allansford Bridge, Allansford, c. 10 km E of Warrnambool, *Ewers s.n.*, Aug 1986 (herb. EWERS); Mt Eccles, *Ewers s.n.*, Oct 1988 (herb. EWERS).

20. Pertusaria persulphurata *Müll. Arg.*
(Müller 1891a: 391).

Type: Queensland: Brisbane, *Bailey s.n.*; holo G.

Pertusaria sulphurata Müll. Arg. (Müller 1893b: 125). Type: Queensland: Brisbane, *Bailey s.n*, 1891; holo G.

Thallus usually thin, rarely thick, pale to bright yellow, areolate and cracked, surface smooth and dull, with sparse to numerous scattered yellow soralia, 0.3–0.5 mm diam., saxicolous; verrucae and spores absent.

Chemistry: K-, KC+ orange-red, C+ orange, Pd-; thiophaninic acid, ± lichexanthone ± stictic acid. The chemistry of *P. persulphurata* (as *P. sulphurata*) was reported in detail by Elix et al. (1978).

P. persulphurata occurs in Queensland and New South Wales; it is a common and conspicuous species on exposed rock, often occuring with *P. paeminosa* (q.v.). *P. fallax* f. *sulphurea* was reported from Victoria (Wilson 1887) but Wilson's specimens with this name [from Upper Maffra (*Wilson 476*, NSW), Kilmore (NSW L4437) and Kew (NSW L4439)] are *P. persulphurata*.

P. persulphurata is distinguished from the yellow saxicolous *P. xanthoplaca* Müll. Arg. (q.v.) by the absence of verrucae and spores, and the presence of soralia.

Similar material, but with the soralia replaced by isidia, has also been seen from Queensland and other specimens, lacking both soralia and isidia, have also been seen and these are all tentatively included in P. *persulphurata*. In addition, specimens have been seen with yellow soralia on an off-white thallus; these appear a dull yellow in contrast to the bright yellow appearance of *P. persulphurata* which has yellow soralia on a yellow thallus. There is no chemical difference between these groups of specimens.

Also examined (6 out of 33): Queensland: Petford, c. 150 km W of Cairns, *Hafellner 15091*, 1979 (GZU); Brampton Island, *Gilbert s.n.*, Aug 1972 (HO 50933); Lamington National Park, Castle Crag, *Brownlie A91*, May 1969 (MEL 1023504). New South Wales: Georges Creek, Macleay River, *Boorman s.n.*, Jan 1907 (NSW L4438); Karuah River, W of Stroud, *Filson 15331*, May 1975 (MEL 1035840); 5 km N of Tenterfield, *Laugher s.n.*, Aug 1975 (HO 50687).

21. Pertusaria petrophyes *Knight*
(Knight 1882: 47).

Type: New South Wales: [neighbourhood of Sydney, fide Filson (1986)], *Knight 48, –*; holo WELT; iso H-NYL 23608 n.v.

Thallus off-white to pale fawn, thin to effuse, surface rough and dull, saxicolous; verrucae numerous, crowded, sometimes confluent, flattened hemispherical with irregular outline, some constricted at the base, often inconspicuous on rough substrates, 1–2 mm wide; ostioles inconspicuous, black, 1 or 2 per verruca; spores 8 per ascus, uniseriate, ellipsoid, smooth, 60–85 µm long, 25–45 µm wide.

Chemistry: K-, KC+ weak orange C+ weak orange, Pd-; thiophaninic acid and lichexanthone.

P. petrophyes is superficially similar to *P. lophocarpa* but is distinguished from that taxon by the slightly larger spores and the different chemistry.

Also examined: Queensland: Cunninghams Gap National Park, on basaltic rock, *Hafellner 15304*, Sep 1986 (GZU). New South Wales: Sydney, hills of Mona Vale, *Bibby s.n.*, Feb 1942 (MEL 1023569); roadside between Sandy Hollow and Hollydeen, W of Muswellbrook, *Mayrhofer 8257*, Aug 1989 (GZU).

22. Pertusaria plicatula *Müll. Arg.*
(Müller 1895a: 635).

TYPE: QUEENSLAND: s.loc., *Knight 41 p.p.*, 1887; holo G.

Pertusaria straminea Müll. Arg. (Müller 1895a: 638). TYPE: QUEENSLAND: Thursday Island, *Hartmann s.n*, 1887; holo G.

Thallus pale olive-green, thick, slightly wrinkled, cracked and areolate, surface smooth and dull, corticolous; verrucae conspicuous, numerous, occasionally confluent, slightly flattened hemispherical, 0.5–1.0 mm wide, becoming constricted at the base, the centre often depressed; ostioles inconspicuous, pale to dark brown, 1 to 5 per verruca, occasionally confluent; spores 2 per ascus, uniseriate, smooth, elongated ellipsoid, 100–137(–160) µm long, 30–45 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; 4,5-dichlorolichexanthone and stictic acid.

P. plicatula is characterised by the two-spored asci and the presence of 4,5-dichlorolichexanthone and stictic acid. It is distinguished from the morphologically and chemically similar *P. communis* var. *neo-caledonica* Nyl. (Nylander 1867) [lectotype (here selected): New Caledonia, *Pancher s.n*, 1862; H-NYL 22855] by the smooth spores (rough in var. *neo-caledonica*).

ALSO EXAMINED: QUEENSLAND: Kuranda Range, NW of Cairns, *Kalb 19915*, Aug 1988 (herb. KALB). VANUATU [as New Hebrides]: Aniwa, *Wilson s.n.*, – 1891 (H).

23. Pertusaria schizostomella *Müll. Arg.*
(Müller 1895a: 637).

TYPE: NEW SOUTH WALES: s.loc., *C. Knight 31*, – ; holo G.

Thallus pale yellowish green to pale greyish green, slightly or coarsely cracked and areolate, surface smooth or very slightly rough, dull, corticolous; verrucae scattered or crowded and becoming confluent, conspicuous, 0.5–1 mm diam., very slightly flattened hemispherical, not constricted at the base; ostioles conspicuous, pale, translucent, becoming dark in the centre, 1 per verruca; spores 2 per ascus, uniseriate, rough, ellipsoid, 80–120 µm long, 30–45 µm wide.

CHEMISTRY: K-, KC+ orange, C+ orange, Pd-; thiophaninic and stictic acids.

P. schizostomella occurs in Queensland and New South Wales; it grows on mangroves and other unspecified trees. It is distinguished from the chemically and morphologically similar *P. thiospoda* by the rough spores, in contrast to the smooth spores in the latter taxon.

ALSO EXAMINED (6 out of 11): QUEENSLAND: Turkey, *Stevens 1241*, Aug 1975 (BRIU); Indooroopilly, *Hafellner 18578, 19284*, Aug 1986 (GZU). NEW SOUTH WALES: Newport, *Wilson s.n.*, Oct 1881 (NSW L4499); Mangrove Creek, near Spencer, *Mayrhofer 6585*, Jan 1985 (GZU); Tweed Heads, *Ewers s.n.*, July 1989 (herb. EWERS).

24. Pertusaria subrigida *Müll. Arg.*
(Müller 1895a: 636).

TYPE: QUEENSLAND: Brisbane, *Bailey 1570 (vide infra)*, 1891; holo G.

Thallus pale olive-green, coarsely cracked and areolate, surface irregularly tuberculate and dull, corticolous; verrucae conspicuous, scattered, approximately hemispherical, becoming constricted at the base, 1–1.5 mm diam.; ostioles inconspicuous, black, often sunken, 1 to 3 per verruca; spores 5–8 per ascus, irregularly uniseriate, fusiform, smooth, 70-110 µm long, 30–37 µm wide.

CHEMISTRY: K-, KC-, C-, Pd-; no lichen compounds detected by thin-layer chromatography.

P. subrigida is characterised by the fusiform spores and the absence of lichen compounds detectable by thin-layer chromatography; it is distinguished from the morphologically similar *P. leucostigma* by the absence of 2-O-methylperlatolic acid. It occurs in eastern Queensland and New South Wales.

There is some confusion surrounding the number of the holotype specimen. The protologue refers to 'Bailey n.1870' but the herbarium specimen is labelled 'Bailey 1570'. Shirley (1896) re-published Müller's descriptions (Müller 1895a) of 13 Queensland *Pertusaria* species in English and under *P. subrigida* referred to specimens from Brisbane and Toowoomba as 'Shirley no. 1870'! The herbarium specimen 'Bailey 1570' is also labelled 'Lecan. & Lecid. N.18' [Lecanoreae et Lecideeae Australienses novae, species number 18 (Müller 1895a)] and is therefore the holotype. The difference between the number on the specimen and in the protologue is probably a printer's error as suggested by Filson (1986: 226).

ALSO EXAMINED: QUEENSLAND: Mt Bullen, Bunya Mountains, *Kalb 20249, 20271*, Aug 1988 (herb. KALB). NEW SOUTH WALES: Currowan State Forest, 2 km NW of Batemans Bay, *Elix 21316*, Dec 1986; Buladelah, Myall State Forest, *Kalb 17938*, Aug 1988 (herb. KALB); Barrington Tops National Park, *Kalb 17988, 17998*, Aug 1988 (herb. KALB).

25. Pertusaria thiospoda *Knight*
(Knight 1882: 47).

TYPE: NEW SOUTH WALES: [neighbourhood of Sydney, fide Filson (1986)], *Knight 20*, –; holo WELT.

Pertusaria leiotera Müll. Arg. (Müller 1884: 285). TYPE: QUEENSLAND: Rockhampton, *Thozet s.n.*, –; holo BRI.

Pertusaria minuta Knight in Shirley (Shirley 1889: 143). TYPE: QUEENSLAND: s.loc., *F. Bailey s.n.*; holo WELT.

Thallus pale yellowish white to pale yellow, thin, margin effuse, slightly cracked, surface smooth and dull, corticolous; verrucae inconspicuous, scattered to crowded, occasionally confluent, hemispherical, sometimes flattened, 0.5–1.0 mm diam., not constricted at the base; ostioles pale brown to black, 1 per verruca; spores 2 per ascus, uniseriate, ellipsoid, smooth, 80–110(–120) µm long, 30–40 µm wide.

CHEMISTRY: K-, KC+ yellow-orange, C+ yellow-orange, Pd-; thiophaninic acid, stictic acid with or without constictic acid (tr).

P. thiospoda is characterised by the pale yellow thallus, reacting KC+ and C+ orange, and the two-spored asci. It occurs in eastern Queensland and New South Wales, and rarely in the Northern Territory, Victoria and Tasmania, and also on Lord Howe Island, Norfolk Island and in Vanuatu. It grows on mangroves, *Casuarina*, *Cyathodes* and introduced trees such as *Cotoneaster*.

In appearance, chemistry and number of spores per ascus, P. *thiospoda* resembles *P. subflavens* Müll. Arg., which was first described from Socotra, Indian Ocean (Müller 1882b) and was later reported from Queensland (Shirley 1889). An examination of the holotype from Socotra [Socotra, Wadi-Kesche, *Dr. Schweinfurth s.n.*, May 1881, G] showed it to contain thiophaninic and stictic acids but the spores (two per ascus) are larger than those of *P. thiospoda*, being 140–165 µm long and 55–60 µm wide, and are also slightly rough. No specimens corresponding to *P. subflavens* have been found among the Australian collections examined and the report of this taxon in Australia may be based on a misidentification of the more common *P. thiospoda*.

P. thiospoda is distinguished from the chemically and morphologically similar *P. schizostomella* by the smooth spores, while the spores are rough in the latter taxon.

Also examined (8 out of 51): Queensland: Burrum Heads, *Stevens 1135*, Aug 1975 (BRIU). New South Wales: Laurieton, *Stevens 2011*, Aug 1977 (BRIU). Victoria: Kew, *Wilson s.n.*, Dec 1884 (NSW L4493 p.p.). Tasmania: Hogans Island, Bass Strait, *Whinray s.n.*, Dec 1973 (MEL 1013008). Northern Territory: Bend 7, Tomkinson River, Arnhem Land, *Grace s.n.*, May 1975 (MEL 1013779). Lord Howe Island: *Watts s.n.*, May 1904 (NSW L4551). Norfolk Island: *Maiden and Boorman s.n.*, Nov 1902 (NSW L4431). Vanuatu [as New Hebrides]: s.loc., *Wilson s.n.*, – 1895 (NSW L4652).

26. Pertusaria trimera *(Müll. Arg.) A. Archer*, **comb. nov.**

Basionym: *Pertusaria pustulata* (Ach.) Duby var. *trimera* Müll. Arg. (Müller 1893a: 42).

Lectotype (here selected): Victoria, 'at Kew, at Oakleigh & at Camperdown' [although there are three localities on the label, there is only one specimen], *F.R.M. Wilson 473*; lecto G; residual syntypes: *F.R.M. Wilson 474 p.p., F.R.M. Wilson 481, F.R.M. Wilson 483*; G.

Pertusaria melaleuca (Sm. & Sowerby) Duby var. *trispora* Müll. Arg. (Müller 1893a: 42). Syntypes: Victoria, 'at Kew, at Youyangs and at Doncaster' [although there are three localities on the label, there is only one specimen], *F.R.M. Wilson 474 p.p.*, 1892; Kew, *F.R.M. Wilson 482*, 1892; G, NSW.

Thallus pale greyish green to pale yellowish green, thin, slightly cracked, surface smooth and dull, corticolous; verrucae conspicuous, scattered, rarely confluent, very flattened hemipherical 0.4–0.8 mm diam.; ostioles conspicuous, black, 1 to 4 per verrucae; spores 3 to 4 per ascus, uniseriate, elongate-ellipsoid, smooth, 70–110 µm long, 30–40 µm wide.

Chemistry: K- or K+ red, KC+ orange, C+ orange, Pd- or Pd+ yellow; thiophaninic acid and 2-O-methylperlatolic acid and/or norstictic acid.

Variety *trimera* and variety *trispora* are morphologically similar, with yellow thalli due to the presence of thiophaninic acid, and similar verrucae and ostioles, each with three to four smooth, ellipsoid spores of similar size in the ascus. Jean Müller even included parts of the same specimen, *Wilson 474*, as syntypes for both varieties (Müller loc. cit.). Both taxa were published in the same article but var. *trimera* was described in more detail than var. *trispora* and var. *trimera* is typified by a better range of specimens. *P. 'melaleuca'* var. *trispora* is therefore considered to be a synonym of *P. pustulata* var. *trimera*.

P. pustulata (Ach.) Duby is a two-spored, temperate species of the Northern Hemisphere (Dibben 1980: 105) containing an unknown xanthone and stictic acid and is therefore unrelated to *P. pustulata* var. *trimera*. This variety is accordingly raised to species level, under the name *P. trimera* following Recommendation 61A3 of the International Code of Botanical Nomenclature 1988.

P. trimera occurs in Western Australia, South Australia, Victoria and Tasmania; it is characterised by the yellow thallus, small verrucae with conspicuous black ostioles and 4 spores per ascus.

When J. Müller described *P. pustulata* var. *trimera* he cited four specimens, *Wilson 473, 474 p.p., 481* and *483*; the specimen *Wilson 473* is the only specimen labelled with a written reference to the publication viz. 'L. Wilson n. 61' [Lichenes Wilsoniani, taxon number 61 (Müller, 1893)] and is therefore chosen as lectotype.

Also examined (11 out of 25): Victoria: Gippsland, *Campbell* s.n., Dec 1885 (NSW L4489); near Dimboola, *Reader s.n.*, June 1896 (NSW L4544); Capi Plain, Wyperfeld National Park, *Filson*, Aug

1978 (MEL 1023060); Mt Arapiles, *Mayrhofer 6638*, Aug 1981 (GZU). TASMANIA: Campbell Town near Elizabeth River, *Bratt 4082*, June 1967 (HO 51157); near Broadmarsh Post Office, c. 30 km NNE of Hobart, *Bratt 68/541*, July 1968 (HO 51140). SOUTH AUSTRALIA: Talbots Reserve, 4.5 km W of Tepko, Mt Lofty Ranges, *Elix 9414*, Oct 1981 (ANUC); Penola Forest Reserve, *Munir 54788*, Nov 1981 (AD 20147 p.p.). WESTERN AUSTRALIA: 40 km E of Ravensthorpe on Highway 1, *Richardson 291*, Apr 1980 (PERTH 000946); Gairdner River, at South Coast Highway, *Richardson 250*, Apr 1980 (PERTH 000946); 10 km S of Kulin, *Hnatiuk 770537*, July 1977 (PERTH 000621).

27. Pertusaria undulata *Müll. Arg.*
(Müller 1893b: 126).

TYPE: QUEENSLAND: s.loc., *Hartmann s.n.*; holo G; iso BM n.v.

Thallus pale olive green, coarsely cracked and areolate, surface slightly rough and dull, corticolous; verrucae inconspicuous, flattened hemispherical or irregular in outline, becoming slightly constricted at the base, rarely confluent, 0.5–1.5 mm diam., sometimes concave on top; ostioles inconspicuous, pale, 1 or 2 per verruca; spores 8 per ascus, irregularly biseriate, elongate-ellipsoid to fusiform, smooth, 67–85 µm long, 27–35 µm wide.

CHEMISTRY: K+ red, KC-, C-, Pd+ yellow; 4,5-dichlorolichexanthone and norstictic acid.

P. undulata was also reported from Toowoomba (Shirley 1893). The taxon is characterised by the eight fusiform spores and the presence of norstictic acid and is distinguished from the chemically similar *P. hartmannii* (both react K+ red) by the number of spores (two per ascus in *P. hartmannii*). Müller in the protologue related *P. undulata* to *P. gibberosa* but noted differences in the ostioles and the size of spores. These two taxa are distinguished by the arrangement of the spores within the ascus and by the K+ red reaction of *P. undulata*, which is negative with *P. gibberosa*.

ALSO EXAMINED: QUEENSLAND: Weyba River Estuary, Noosaville, *Elix 19308*, Sep 1985 (ANUC). NEW SOUTH WALES: Minyon Falls, 25 km NE of Lismore, *Verdon 3935*, Oct 1982 (CBG 7809416).

28. Pertusaria velata *(Turn.) Nyl.*
(Nylander 1861: 179).

Parmelia velata Turn. (Turner 1808: 143). TYPE: ENGLAND: Sussex, on ash trees, *Borrer s.n.*, 1805; holo BM n.v.

Pertusaria rhodotropa Müll. Arg. (Müller 1895a: 637). LECTOTYPE (here selected): QUEENSLAND: s.loc., *Knight 308 p.p.*; lecto G; residual syntypes: *Knight 30, 32 p.p., 307, 309*, all in G.

Thallus greyish white to off-white, thick, slightly cracked and areolate, surface smooth to slighly wrinkled, dull; esorediate, corticolous; verrucae numerous, crowded, immature verrucae irregularly hemispherical or subspherical, constricted at the base, 0.5–1.0 mm wide, mature verrucae becoming flattened and exposing pale to dark reddish brown discs, 0.5–0.8 mm diam., slightly or densely white pruinose; spores 1 per ascus, uncommon, smooth, ellipsoid, thin-walled, 110–140(–175) µm long, 30–45 µm wide.

CHEMISTRY: K-, KC+ orange, C+ orange, Pd-; lecanoric acid.

P. velata is a widespread species with a pantropical and temperate distribution; it has been reported from Europe, North and South America [including Brazil (Vainio 1890)], China, Japan, Hawaii, the Philippines and the Mariana Islands (Dibben 1980: 78). It has also been reported from New Caledonia (Nylander 1867) and, in Australia, from Queensland (Shirley 1889) and New South Wales (Elix & Streimann 1982). *P. velata* is

found in Australia at or near sea-level in eastern Queensland and New South Wales; it grows predominantly on mangroves and also on other unspecified trees.

Müller (loc. cit.) compared *P. rhodotropa* to the Central American *P. subvaginata* Nyl. (Nylander 1866), which was reported from Brisbane (Müller 1891a), Bundaberg (Shirley 1891) and Toowoomba (Müller 1892). An examination of the holotype of *P. subvaginata* Nova Granata, *Lindig s.n.*; H-NYL 23508] showed it to contain lichexanthone, which distinguishes this species from *P. rhodotropa*. *P. subvaginata* has not been found among the recent *Pertusaria* collected in Queensland or New South Wales.

When Müller described *P. rhodotropa* he cited five specimens, *Knight 30, 32 p.p., 307, 308 p.p.*, and *309*. The specimen labelled *'Knight 308 p.p.'* is the only specimen with a reference to the publication viz 'Lecan. & Lecid. no. 13' [Lecanoreae et Lecideeae Australienses novae, species number 13 (Müller 1895a)] and this specimen is therefore selected as lectotype.

A chemically and morphologically similar taxon, so far unnamed, occurs in Western Australia but this is distinguished from *P. velata* by its eight-spored asci.

P. velata is characterised by the single-spored asci and the KC+ orange reaction, due to the presence of lecanoric acid.

Also examined (12 out of 50): Queensland: North Stradbroke Island, *Rogers 242*, May 1973 (BRIU); Fraser Island, *Stevens 713*, May 1975 (BRIU); Turkey, *Stevens 1236*, Aug 1975 (BRIU); 25 km S of Lockhart, *Hill s.n.*, Sep 1976 (MEL 1035496). New South Wales: Park Beach, Coffs Harbour *Elix 3428*, June 1977 (ANUC); Jervis Bay, *Verdon 3092*, Sep 1977 (CBG 7802797 p.p.); Diamond Creek, 22 km SW of Moruya, *Verdon 5082*, Nov 1981 (CBG, H); Cowan Creek, c. 30 km N of Sydney, *Archer P86, P92*, Jan 1990 (NSW). Vanuatau [as New Hebrides]: on coconut palm, *Wilson 1834*, – 1895 (NSW). U.S.A.: Iowa: Fayette, *Fink s.n.*, Aug 1894 (NSW). Maryland: Baltimore County, *Pitt 54b*, July 1910 (NSW). Louisiana: Washington Parish, Frickes Bluff, *Tucker 25959*, Feb 1984 (BRIU).

29. Pertusaria woollsiana *Müll. Arg.*
(Müller 1882a: 485).

Type: New South Wales: Parramatta, *Woolls s.n.*, 1879; holo G; iso MEL 7288.

Thallus off-white to pale greyish green, slightly cracked and areolate, surface smooth and dull, corticolous; verrucae conspicuous, numerous, scattered, flattened hemispherical, not constricted at the base, 0.5–1 mm diam.; ostioles inconspicuous, dark brown, 2 to 7 per verruca; spores 6 to 8 per ascus, uniseriate, ellipsoid, smooth, 53–60 µm long, 24–30 µm wide.

Chemistry: K-, KC-, C-, Pd-; 4,5-dichlorolichexanthone and 2-o-methylperlatolic acid.

P. woollsiana is known only from the type specimens. J. Müller (loc. cit.) reported *P. woollsiana* to contain four spores per ascus but the type material contains at least six mature spores per ascus with some asci containing eight immature spores. The material examined resembles *P. gibberosa* (q.v.) and differs only in the chemistry.

30. Pertusaria xanthoplaca *Müll. Arg.*
(Müller 1882a: 485).

Type: Queensland: Toowoomba, *Hartmann 32*, 1881; holo G; iso MEL 7286.

Thallus bright yellow, thin, minutely cracked and areolate, surface smooth and dull, rarely isidiate, esorediate, saxicolous; verrucae scattered or numerous, rarely confluent, slightly flattened hemispherical, becoming constricted at the base, 0.5–1 mm diam.; ostioles inconspicuous, pale or becoming dark, 1 per verruca; spores 8 per

ascus, irregularly uniseriate, ellipsoid, rarely becoming subfusiform, smooth, 50–75 µm long, 25–37 µm wide.

CHEMISTRY: K-, KC+ orange, C+ orange, Pd-; thiophaninic acid, lichexanthone and rarely lacking stictic acid.

ALSO EXAMINED (7 out of 16): QUEENSLAND: Brampton Island, *Gilbert* s.n., Aug 1974 (HO 50946); Cooktown Road, 3 km NW of Mt Molloy, *Elix 17184*, July 1984 (ANUC); Paluma Valley Reservoir, Hidden Valley Track, 34 km SSW of Ingham, *Elix 20299*, June 1986 (ANUC); Mt Stuart, 10 km SSW of Townsville, *Elix 21230*, July 1986 (ANUC); Glasshouse Mtns, 3 km S of Crookwell, *Hafellner 15813*, July 1986 (GZU). NEW SOUTH WALES: Port Macquarie, *Elix 1067*, Aug 1975 (ANUC); Broken Head, 8 km S of Byron Bay, *Elix 21253*, Aug 1986 (ANUC).

P. xanthoplaca occurs in eastern Queensland and New South Wales on rhyolite, granite, porphyry and volcanic rock, from sea level to 880 m. It is chemically similar to *P. persulphurata* but is differentiated from that species by the absence of soralia and the frequent presence of fertile verrucae.

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References

Archer, A.W. (1978) 3-Methyl-2-benzothiazolone hydrazone hydrochloride as a spray reagent for phenolic lichen compounds. *J. Chromatogr.* 152: 290–292.

Archer, A.W. (1987) Two new lichens: *Cladonia squamosula* var. *subsquamosula* and *C. sulcata* var. *striata* with notes on chemotaxonomy within the species. *Muelleria* 6(5): 383–388.

Archer, A.W. (1990) A new species in the lichen genus *Pertusaria* from the Southern Hemisphere: *Pertusaria paeminosa*. *Nova Hedwigia* 50: 395–399.

Culberson, C.F. (1972) Improved conditions and new data for the identification of lichen compounds by a standardised thin-layer chromatographic method. *J. Chromatogr.* 72: 113–125.

Dibben, M.J. (1980) *The chemosystematics of the lichen genus* Pertusaria *in North America north of Mexico*. Milwaukee Public Museum Publications in Biology and Geology, Number 5. (Milwaukee).

Elix, J.A., Musidlak, H.W., Sala, T. & Sargent, M.V. (1978) Structure and synthesis of some lichen xanthones. *Austral. J. Chem.* 31: 145–155.

Elix, J.A. & Streimann, H. (1982) New lichen records for Australia. *J. Hattori Bot. Lab.* 51: 69–97.

Filson, R.B. (1986) *Index to the type specimens of Australian lichens, 1800-1984*. Australian Flora and Fauna Series Number 4. (Australian Government Publishing Services: Canberra).

Galloway, D. J. (1985) *Flora of New Zealand lichens*. (Government Printer: Wellington).

Hanko, B. (1983) *Die Chemotypen der Flechtengattung* Pertusaria *in Europa*. Bibliotheca Lichenologica Band 19. (J. Cramer: Vaduz).

Knight, C. (1882) Contributions to the lichenographia of New South Wales. *Trans. Linn. Soc. London, Bot.* 2: 37–51.

Körber, G.W. (1862) Reliquiae Hochstetterianae. *Abh. Schles. Ges. Vaterl. Cult., Abth. Naturwiss.* 2: 30–34.

Magnusson, A. H. (1955) A catalogue of the Hawaiian lichens. *Arkiv för Botanik, ser.* 2, 3: 223–402.

Müller, J. (1881) Lichenologische Beiträge XIV. *Flora* 64: 513–527.

Müller, J. (1882a) Lichenologische Beiträge XVI. *Flora* 65: 485–486.

Müller, J. (1882b) Diagnoses lichenum socotrensium novorum. *Proc. Roy. Soc. Edinburgh* 11: 461.
Müller, J. (1883) Lichenologische Beiträge XVII. *Flora* 66: 75–80.
Müller, J. (1884) Lichenologische Beiträge XIX. *Flora* 67: 349–354; 460–468.
Müller, J. (1891a) Lichenes Brisbanenses. *Nuovo Giorn. Bot. Ital.* 23: 385–404.
Müller, J. (1891b) Primitiae Florae Costaricensis. Lichens. *Bull. Soc. Roy. Bot. Belgique.* 30(1): 49–97.
Müller, J. (1892) Lichenes exotici Herbari Vindobonensis. *Ann. K. K. Naturhist. Hofmus.* 7: 302–305.
Müller, J. (1893a) Lichenes Wilsoniani. *Bull. Herb. Boissier* 1: 33–65.
Müller, J. (1893b) Lichenes Exotici II. *Hedwigia* 32: 120–136.
Müller, J. (1895a) Lecanoreae et Lecideeae Australienses novae. *Bull. Herb. Boissier* 3: 632–642.
Müller, J. (1895b) Lichenes Exotici III. *Hedwigia* 34: 27–38.
Nylander, W. (1859) Lichenes Exotici. *Ann. Sci. Nat. Bot.* (4)11: 241.
Nylander, W. (1861) *Lichenes Scandinaviae* (Helsinki).
Nylander, W. (1866) Collectio Lichenum ex Insula Cuba. *Flora* 49: 289–295.
Nylander, W. (1867) Synopsis Lichenum Novae Caledoniae. *Bull. Soc. Linn. Normandie* ser.2, 2: 508–521.
Nylander, W. (1890) *Lichenes Japoniae* (Paris).
Shirley, J.F. (1889) The Lichen Flora of Queensland. *Proc. Roy. Soc. Queensland* 6: 138–145.
Shirley, J.F. (1891) in Bailey, F.M., Contributions to the Queensland Flora, Botany Bulletin III. *Queensland Dept. Agric. Bull.* 9: 26–27.
Shirley, J.F. (1893) in Bailey, F.M., Contributions to the Queensland Flora, Botany Bulletin VIII. *Queensland Dept. Agric. Bull.* (s.n.): 98–99.
Shirley, F.J. (1896) in Bailey, F.M. Contributions to the Queensland Flora, Botany Bulletin XIII. *Queensland Dept. Agric. Bull.* (s.n.): 20–22.
Stirton, J. (1876) New and rare lichens. *Trans. Glasg. Soc. Fld. Nats.* 4: 93.
Turner, D. (1808) Description of eight new British lichens. *Trans. Linn. Soc. London* 9: 135–150.
Vainio, E.A. (1890) Etude sur la classification naturelle et la morphologie des lichens du Brésil. Pars prima. *Acta Soc. Fauna Flora Fenn.* 7(1): 1–247.
Wilson, F.R.M. (1887) Notes on a few Victorian lichens. *Victorian Naturalist* 4: 83–87.
Zahlbruckner, A. (1928) *Catalogus lichenum universalis* vol. 5 (Leipzig).
Zahlbruckner, A. (1941) Lichenes Novae Zelandiae a cl. H. H. Allan eiusque collaboratoribus lecti. *Kaiserl. Akad. Wiss. Wien math.-naturwiss. Kl., Denkschr.* 104: 249–380.

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A revision of the complex species *Persoonia mollis* (Proteaceae)

Siegfried L. Krauss and L.A.S. Johnson

Abstract

Krauss, Siegfried L.[1] *& Johnson, L.A.S.*[2] *([1] Department of Biology, University of Wollongong, NSW, Australia 2500; [2] National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. A revision of the complex species* Persoonia mollis *(Proteaceae).* Telopea *4(2): 185–199. Persoonia mollis* R. Br. sens. lat. is circumscribed and revised, and a key and descriptions are provided for the nine taxa recognised as subspecies. Five new subspecies are described in *P. mollis*: subsp. *maxima* S. Krauss & L. Johnson, subsp. *nectens* S. Krauss & L. Johnson, subsp. *leptophylla* S. Krauss & L. Johnson, subsp. *livens* S. Krauss & L. Johnson, and subsp. *budawangensis* S. Krauss & L. Johnson. Three new combinations are made: *P. mollis* R. Br. subsp. *caleyi* (R. Br.) S. Krauss & L. Johnson, *P. mollis* R. Br. subsp. *revoluta* (Sieber ex Schultes & Schultes f.) S. Krauss & L. Johnson, and *P. mollis* R. Br. subsp. *ledifolia* (A. Cunn. ex Meisner) S. Krauss & L. Johnson.

Introduction

Persoonia mollis sens. lat., as here defined, is clearly separated from all other species, and constitutes a monophyletic group. It embraces four species recognised by Bentham (1870: 398–399): *P. caleyi* R. Br., *P. revoluta* Sieber ex Schultes & Schultes f., *P. ledifolia* A. Cunn. ex Meisner, as well as *P. mollis* R. Br. (sens. strict.). The recognition of these four species led to much confusion and uncertainty regarding their limits, as well as difficulty in the determination of quite typical specimens of each, and even of other quite distinct species. Increased herbarium material, as well as acquaintance with the plants in the field, has led to a better understanding. We have concluded that the three subspecies listed under informal designations in Jacobs and Pickard (1981) do not adequately reflect the extent of variation within the group. The overall morphological variation is complex and in places somewhat clinal in nature, but nine allopatric and parapatric taxa can be distinguished. Some of these are connected by more or less broad hybrid zones, while others apparently have sharp boundaries. This is discussed further under each of the taxa treated below.

Although the assemblage includes taxa of quite strikingly different aspect and suggests comparison with some others treated as species-groups (e.g. the *P. nutans* – *P. myrtilloides* group) by Weston and Johnson (1991), we have considered it appropriate at this stage to recognise a single broadly defined species, treating the nine component taxa as subspecies.

P. mollis sens. lat. possesses a clear and significant synapomorphy that unites the subspecies and distinguishes the clade from all others. *Persoonia* fruits are fleshy drupes with a hard woody endocarp surrounding the (usually) single seed (Johnson & Briggs 1975). The endocarp in *Persoonia*, anatomically and in transverse section, is typically a solid, continuous woody structure composed of stone cells with very small lumina. The *P. mollis* endocarp, however, contains a number of large tanniniferous sclereids with large lumina interspersed throughout the normal structure of the endocarp. Further, the combination of linear to lanceolate convex leaves that have recurved to revolute margins and are markedly paler beneath, short erect pedicels, pubescent to villous perianth, yellow anthers that lack appendages, glabrous ovary, 2 ovules and small drupe distinguishes *P. mollis* sens. lat. from all other species.

One of us (SK) is currently undertaking studies into the population biology of this complex. The emphasis is on ecological and genetic (allozyme) variation, in an attempt to elucidate evolutionary processes within the group. Some resolution of the taxonomy of this group is a necessary precursory step to these studies. Also, a revision of the complex is required now for forthcoming volumes of the *Flora of New South Wales* and the *Flora of Australia*.

All specimens cited below have been seen by us unless otherwise indicated.

Persoonia mollis *R. Br.*
Brown (1810a: 161; 1810b: 372)

TYPE CITATION: 'In Novae Hollandiae ora orientali: prope Port Jackson: ad ripas arenosas fluviorum (ubi v.v.).'

LECTOTYPE (here designated): NEW SOUTH WALES: Banks of the Grose, *R. Brown 3285* (BM). POSSIBLE ISOLECTOTYPES: Port Jackson, *R. Brown*, 1803 (NSW 21316, ex BM); Port Jackson, *R. Brown*, (NSW 21317, ex BM); Port Jackson, *R. Brown*, 1801–1805 (NSW 131413, ex BM); Port Jackson, *R. Brown*,– (NSW 21318, ex BM?, ex MEL?).

Linkia mollis (R. Br.) Kuntze (Kuntze 1891: 579).
For further synonyms see under the subspecies.

Prostrate and spreading to erect and branching shrub, 0.2–5 m high, usually as broad as high (broader in subsp. *revoluta*). *Bark* smooth, pale metallic-grey to brown. *Hairs* silky, short to long (0.2–3 mm long), appressed to patent, pale to copper-orange. *Branchlets* slightly angular, from silky-pubescent or spreading-pubescent to densely villous. *Leaves* alternate (spiral phyllotaxy), or some subopposite or sometimes opposite-decussate or whorled, spreading or suberect, not twisted, sessile or narrowed to a very short petiole, linear-filiform, linear, linear-oblong, oblong-lanceolate, narrow-lanceolate, lanceolate, or oblong-ovate, acute, acuminate, obtuse or truncate, 1.5–12 cm long, 0.8–17 mm wide, always transversely convex with margins from closely revolute to slightly recurved, the upper surface markedly darker green than the lower surface, smooth or somewhat scaberulous above, the lower surface markedly more pubescent than the upper, always ± hairy when young, glabrescent, pubescent or villous when mature; venation obscure to evident (brochidodromous), when evident usually only the midvein prominent. *Inflorescence* an auxotelic botryum, 1–30-flowered; rachis 0–15 cm long. *Flowers* solitary, each subtended by a leaf or rarely by a reduced or scale leaf, on short pubescent pedicels 1–3 mm long; buds just prior to anthesis 8–12 mm long, silky-pubescent, pubescent, villous, or densely villous, rarely ± glabrous; tepals yellow, 7–11.5 mm long, obtuse or caudate, usually constricted below the anthers, abaxial surface shortly and sparsely pubescent to densely villous; anthers (2.5–)3–4.5(–5) mm long, yellow; filaments 2.8–4.8 mm long; glands deltoid or truncate, short, not very prominent. *Ovary* glabrous, stipitate, the stipe 0.6–1.5 mm long; ovules 2. *Drupe* stipitate, obliquely ovoid-globular or subglobular, small, c. 8 mm long, c. 7 mm diam., green becoming purplish-brown, crowned by the slender persistent style; endocarp woody, interspersed with tanniniferous sclereids. *Cotyledons* (4–) 5 (–6).

FLOWERING PERIOD: Late December to May and occasionally as late as August (see also under the subspecies).

HABITAT: Widespread, from exposed coastal heath, to dry and wet sclerophyll forest and woodland, to very sheltered and moist gullies, predominantly on sandy soils on sandstone and undifferentiated metasediments, from near sea-level to 1100 m altitude (see also under the subspecies).

DISTRIBUTION: Central and South Coast regions of New South Wales from O'Hares Creek catchment area to Durras Lake, and Central and Southern Tableland regions from the upper and lower Blue Mountains south to the southern Budawang Range, and west to Goulburn, with a disjunct occurrence in the Hornsby area (Figure 1).

Key to the subspecies

1 Leaves large, lanceolate to narrow-lanceolate, 4–8(–12) cm long, 6–17 mm broad, the margins recurved (often minutely)
  2 Buds (and to a lesser extent young branchlets and young leaves) densely villous (velvety) to villous with erect, whitish to copper-coloured hairs 1–3 mm long. Leaves (young leaves especially) soft
    3 Buds (and to a lesser extent young branchlets and young leaves) densely villous (velvety) to villous, the hairs c. 1 mm long, whitish when fresh, copper-coloured when dried ..... 1. subsp. **mollis**
    3* Buds (and to a lesser extent young branchlets and young leaves) villous, the hairs c. 2–3 mm long, copper-coloured when fresh or dried ..... 2. subsp. **maxima**
  2* Buds (and to a lesser extent young branchlets and young leaves) (sparsely-) silky-pubescent, the hairs c. 0.5 mm long, whitish. Leaves pliable but not very soft ..... 3. subsp. **nectens**

1* Leaves small, linear to linear-lanceolate to oblong-lanceolate to oblong-ovate, 1.5–4(–6) cm long, 0.8–6(–15) mm broad (those leaves broader than 0.6 cm are shorter than 4 cm), the margins revolute (rarely recurved)
  4 Leaves linear-lanceolate to oblong-lanceolate to oblong-ovate, 2–6(–15) mm broad, the apex acute, acuminate or obtuse, the margins recurved to revolute (the undersurface exposed when dried)
    5 Habit prostrate, spreading, 0.1–0.5 m high, up to 4 m diameter. Large leaves usually broader than 6 mm, obtuse (-acute) 5. subsp. **revoluta**
    5* Erect shrubs 1.2–4 m high. Leaves always < 6 mm broad, acute to ± obtuse
      6 Leaves linear-lanceolate to narrow-lanceolate, 3–6 cm long, the apex acute ..... 8. subsp. **caleyi**
      6* Leaves oblong-lanceolate to oblong-ovate, 2–4 cm long, the apex ± obtuse
        7 Buds at anthesis 9–11.5 mm long. Longest hairs on buds and young leaf undersurface 0.4–1 mm long. Fitzroy Falls area, north of Kangaroo Valley ..... 4. subsp. **ledifolia**
        7* Buds at anthesis 7.5–10.5 mm long. Longest hairs on buds and young leaf undersurface 0.2–0.6 mm long. Endemic to the Budawang Range ..... 9. subsp. **budawangensis**
  4* Leaves linear to linear-filiform, 0.8–1.5(–2) mm broad, the apex truncate to bluntly acute or obtuse, the margins tightly revolute (when dried the under surface wholly or largely obscured). Dense, compact shrubs 0.8–1.5(–2) m high
    9 Undersurface of leaves densely villous with closely appressed hairs Leaves green to grey-green ..... 7. subsp. **livens**
    9* Undersurface of leaves sparsely villous to villous with closely appressed hairs. Leaves bright green ..... 6. subsp. **leptophylla**

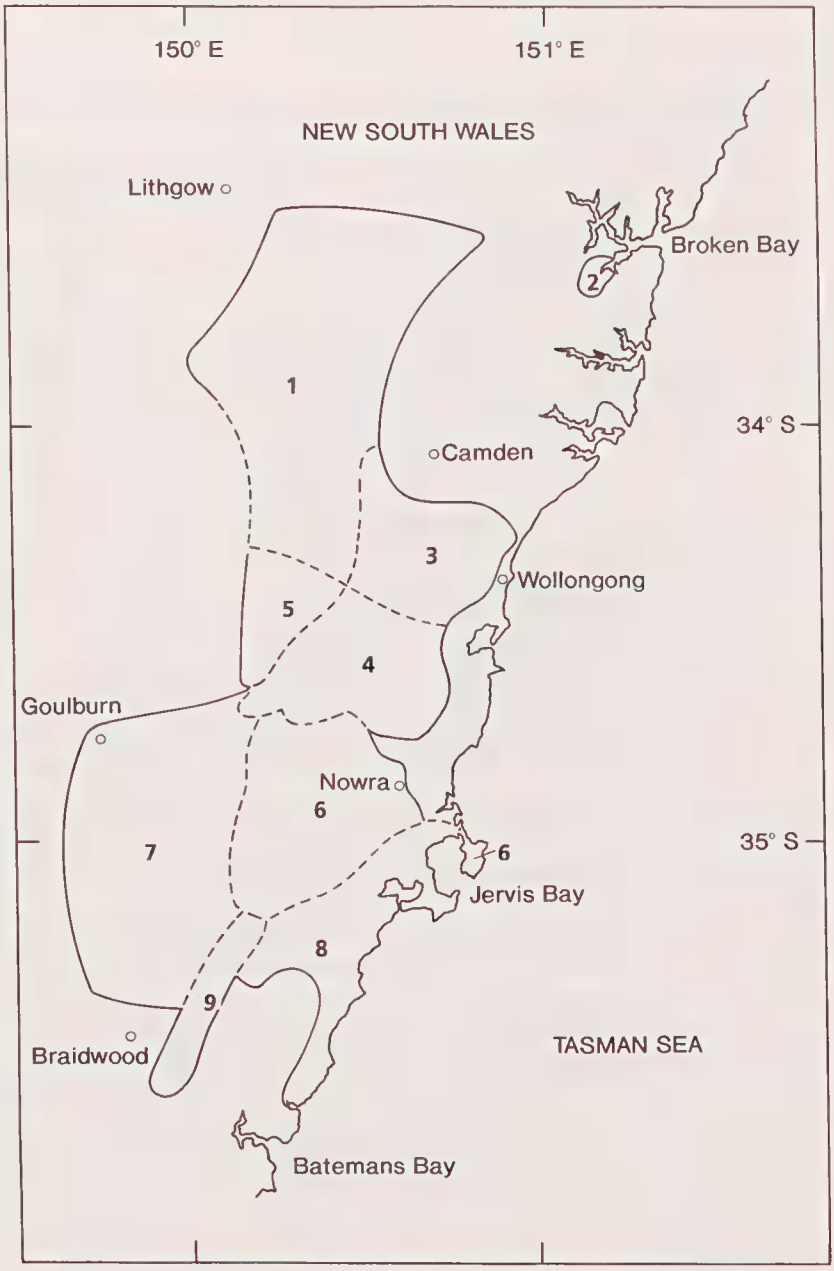

Figure 1. Distribution of *Persoonia mollis* subspecies: **1**, subsp. *mollis*. **2**, subsp. *maxima*. **3**, subsp. *nectens*. **4**, subsp. *ledifolia*. **5**, subsp. *revoluta*. **6**, subsp. *leptophylla*. **7**, subsp. *livens*. **8**, subsp. *caleyi*. **9**, subsp. *budawangensis*. Solid lines indicate more or less exact boundaries. Broken lines indicate either approximate boundaries or hybrid zones.

1. Persoonia mollis *R. Br.* subsp. **mollis**

Erect, branching shrub 1.5–5 m high. *Young stems* villous to velvety with erect, whitish to copper-coloured hairs. *Leaves* soft, narrow-lanceolate, acute, 4–10 cm long, 0.6–1.5 cm wide, villous to velvety on the undersurface when young, the longest hairs of moderate length, c. 1 mm long, erect, whitish to copper-coloured, the margins (minutely) recurved, the midvein usually prominent. *Buds* villous to densely villous with erect whitish to copper-coloured hairs c. 1 mm long. Figure 2.

Flowering period: Late December to April (and sporadically until June).

Habitat: Dry to wet sclerophyll eucalypt forest with a shrubby understorey, in moist, sheltered, forested gullies, rarely in more exposed sites, on sandy soils derived predominantly from (Triassic) Hawkesbury Sandstone and Narrabeen Group sandstone.

Distribution: Widespread but sporadic throughout the upper and lower Blue Mountains (Figure 1).

Conservation status: not rare.

Notes: This subspecies is apparently parapatric with subsp. *nectens* in the Warragamba Dam catchment area. More collections are needed to determine the exact nature of the variation in this area, which could be somewhat clinal.

Selected specimens: New South Wales: Central Coast: Tabarag Ridge, 33°37'S 150°33'E, *Wiecek 6*, 18 Mar 1987 (NSW); 5.3 km W of Kurrajong Heights, 33°31'S 150°35'E, *Coveny 12102 & Dunn*, 15 May 1985 (NSW, B, K, PERTH); c. 1 mile [2.5 km] from Bilpin to Mountain Lagoon, *Salasoo 3200*, 25 Apr 1966 (NSW); Woodford, *Cheel*, Sep 1913 (NSW 21307); Frasers Gully, Springwood, *Camfield*, Mar 1899 (NSW 20924); The Valley, near Springwood, *Maiden*, 7–14 Apr 1888 (NSW); Erskine Creek, 10 miles [16 km] S of Glenbrook, *Whaite 902*, Apr 1951 (NSW). Central Tablelands: Wolgan East, *Constable*, 14 Dec 1948 (NSW 20934); Mt Wilson, *Johnson*, 22 Sep 1949 (NSW 14530); Mt Wilson, *Fletcher*, Jan 1894 (NSW 20926); Mt Victoria, *Maiden*, Dec 1896 (NSW 21299); Shipley Rd, Blackheath, *Burgess*, 27 Feb 1969 (NSW 124902 ex CBG 026091); Lawson, *Dwyer*, Mar 1924 (NSW 21306); Katoomba area, along Six Foot Track to Nellies Glen, 33°42'S 150°17'E, *Taylor 314 & Coveny*, 23 Oct 1984 (NSW, B, K, MO, NBG, PERTH, RSA); Tableland Rd, Kings Tableland, 4.8 km from Great Western Hwy, 33°46'S 150°23'E, *Weston 1267 & Catling*, 31 Oct 1988 (NSW); c. 1 km E of Little Cedar Gap, 33°49'S 150°18'E, *Benson 1935 & Keith*, 29 Mar 1984 (NSW); Jenolan Caves district, *Blakely*, Jan 1900 (NSW 20927). Precise locality uncertain: Blue Mountains, *Cunningham 43*, 1817 (NSW, ex BM); Blue Mountains, *Cunningham 5*, 1827 (NSW 113874, ex BM); New South Wales, *Sieber 54*, 1823 (NSW 131504, ex BM).

2. Persoonia mollis *R. Br.* subsp. **maxima** *S. Krauss & L. Johnson*, **subsp. nov.**

Frutex usque ad 5 m altus, villosus pilis cupreo-aureis 2–3 mm longis, foliis acutis 6–12 cm longis 1–1.7 cm latis.

Holotype: New South Wales: Central Coast: c. 700 m S of Ku-Ring-Gai Rd and c. 100 m E of Sydney-Newcastle Freeway, Ku-ring-gai Chase National Park, 33°40'S 151°09'E, *S. Krauss 206 & L. Howitt*, 24 Mar 1990 (NSW 228176).

Isotypes: AD, B, BRI, CBG, K, MEL, MO, PERTH.

Tall, branching, spreading shrub 2–5 m high. *Young stems* villous with erect copper-coloured hairs. *Leaves* soft, narrow-lanceolate to lanceolate, acute, 6–12 cm long, 1–1.7 cm wide, sparsely villous to villous on the undersurface when young, the hairs c. 2–3 mm long, erect, pale to copper-coloured, the midvein usually prominent, the margins (minutely) recurved. *Buds* sparsely villous to villous, the hairs erect, copper-coloured, c. 2.5–3 mm long. Figure 2.

Derivation of epithet: From the Latin *maximus*, greatest or largest; referring to this

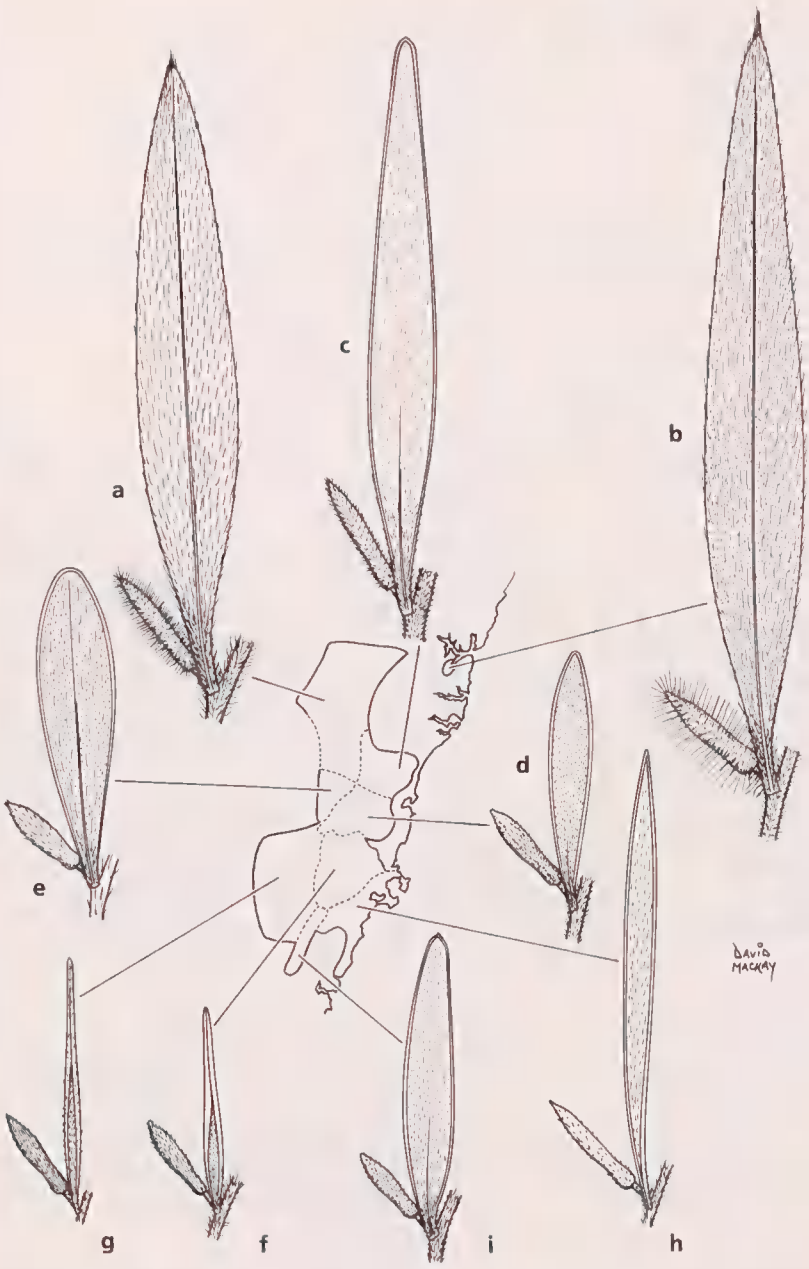

Figure 2. Typical leaf (undersurface) and bud of each *Persoonia mollis* subspecies (x 1.2): **a,** subsp. *mollis* (*R. Brown NSW 21317*). **b,** subsp. *maxima* (holotype). **c,** subsp. *nectens* (holotype). **d,** subsp. *ledifolia* (*Krauss 204*). **e,** subsp. *revoluta* (*Krauss 237 & Johnson*). **f,** subsp. *leptophylla* (holotype). **g,** subsp. *livens* (holotype). **h,** subsp. *caleyi* (*Krauss 227 & Howitt*). **i,** subsp. *budawangensis* (holotype).

subspecies being generally larger in its parts (habit, leaves, buds, flowers, hairs) than all other *P. mollis* subspecies.

Flowering period: Late December to April.

Habitat: In sheltered places in dry sclerophyll (*Angophora costata – Eucalyptus pilularis*) forest with a shrubby scleromorphic understorey, on shallow sandy soils derived from (Triassic) Hawkesbury Sandstone.

Distribution: Restricted to the Hornsby–Asquith–Cowan/Bobbin Creeks area (Figure 1). Only a handful of extant plants are known.

Conservation status: 2EC (using the coding system of Briggs & Leigh (1988)).

Notes: These plants occur extremely sporadically, and only very small populations are known to us. This subspecies is geographically isolated from all others. It is morphologically and geographically closest to *P. mollis* subsp. *mollis*, which occurs about 50 km to the west.

Specimens examined: New South Wales: Central Coast: Hornsby, *Blakely*, Apr 1915 (NSW 21311); Cowan and Bobbin Creek, *Blakely*, Mar 1915 (NSW 21310); above gully SE of Asquith golf course, c. 100 m on track past end of old quarry, 33°42'S 151°06'E, *Thomas*, Feb 1986 (NSW 180348, K, PERTH); Asquith, below the waterfall, *Blakely*, 24 Feb 1918 (NSW 20921).

3. Persoonia mollis *R. Br.* subsp. **nectens** *S. Krauss & L. Johnson*, **subsp. nov.**

Inter subspecies *mollem* et *ledifoliam*. Frutex 1–3 m altus, indumento pilorum pallidorum brevium (c. 0.5 mm longorum), foliis obtusis vel subacutis 4–10 cm longis 0.8–1.5 cm latis.

Holotype: New South Wales: Central Coast: 10R Fire Trail, c. 100 m W of O'Hares Creek, 34°13'S 150°53'E, *D. Keith 122*, 1 Apr 1984 (NSW).

Medium to tall, erect, spreading, branching shrub 1.2–3 m high. *Young stems* sparsely villous with short, whitish, spreading hairs. *Leaves* mesophyllous, pliable but not soft, narrow-lanceolate, obtuse to subacute, 4–10 cm long, 0.8–1.5 cm wide, (sparsely) silky-pubescent on the undersurface when young, the hairs short, c. 0.5 mm long, pale, spreading, the midvein obscure to prominent, the margins (minutely) recurved. *Buds* (sparsely) silky-pubescent, the hairs c. 0.5–1 mm long, pale. Figure 2.

Derivation of epithet: From the Latin *nectens*, binding or connecting, referring to the intervening position geographically and morphologically of this subspecies in relation to subsp. *mollis* and subsp. *ledifolia*.

Flowering period: Late December to April (and sporadically until June).

Habitat: Dry to wet sclerophyll eucalypt forest, usually in moist sheltered sites, on sandy soils derived from (Triassic) Hawkesbury Sandstone.

Distribution: South-west of Sydney, from Oakdale south to Hill Top, and east to the Illawarra escarpment (Figure 1).

Conservation status: not rare.

Notes: North and south-west of Oakdale this subspecies may well intergrade with subsp. *mollis*, although more collections are needed from this area. Specimens from the Hill Top area differ slightly from typical subsp. *nectens* specimens in being slightly more pubescent. In this regard they approach subsp. *mollis* morphologically, and perhaps should be regarded as somewhat intermediate between subsp. *mollis* and subsp. *nectens*. For this treatment, however, we have included them in our con-

cept of subsp. *nectens*. South-west of Mt Kembla, the exact boundary between subsp. *nectens* and subsp. *ledifolia* is unknown, and more collections are needed from the Lake Avon and Lake Nepean water catchment areas.

SELECTED SPECIMENS: NEW SOUTH WALES: Central Coast: Oakdale to Burragorang Lookout, *Johnson*, 5 Sep 1951 (NSW 20928); 2 km ESE of Oakdale Colliery, *Weston 422*, 27 Sep 1984 (NSW); Loddon Falls, *Rodway*, 11 Aug 1935 (NSW 38769); Cataract Catchment area, 34°1-'S 150°4-'E, *White 5095*, 22 Oct 1927 (NSW, ex BRI); Cataract River, *Cheel*, 10 Mar 1907 (NSW 21322); Sublime Point, near Bulli Pass, *C. Davis*, Feb 1941 (NSW 38790); Mt Keira, *Cheel*, 3 Mar 1912 (NSW 21323); Illawarra district, *Hamilton*, Oct 1900 (NSW 21328); Wattle Ridge Rd, 4 km NW of Hill Top Post Office, 34°20'S 150°28'E, *Weston 433 & Dalby*, 15 Jan 1985 (NSW); Wattle Ridge Rd, 2 km N of Hill Top Post Office, 34°20'S 150°29'20"E, *Weston 1040, Crisp & Kater*, 6 Nov 1986 (NSW).

4. Persoonia mollis *R. Br.* subsp. **ledifolia** *(A. Cunn. ex Meisner) S. Krauss & L. Johnson*, **comb. et stat. nov.**

BASIONYM: *Persoonia ledifolia* A. Cunn. ex Meisner (Meisner 1856: 339).

TYPE CITATION: 'Illawarra, A. Cunningham.'

LECTOTYPE (here designated): NEW SOUTH WALES: Illawarra, *A. Cunningham* (NY). Possible parts of the type collection (not seen): The Mountains of the Five Islands District Southward of the Colony of New South Wales, *A. Cunningham no. 17*, 1824 (K); Little Mountain near Bullhi, Illawarra, *A. Cunningham no. 17*, 1824 (K).

Persoonia revoluta Sieber ex Schultes & Schultes f. var. *angustifolia* Benth. (Bentham 1870: 398). LECTOTYPE (here designated): NEW SOUTH WALES: Hanging Rock, Argyle County, *McArthur* (K, photo NSW). EXCLUDED SYNTYPE: Blue Mountains, *Atkinson* (K, photo NSW).

Linkia ledifolia (A. Cunn. ex Meisner) Kuntze (Kuntze 1891: 579)

Small to medium, erect, branching shrub 1–2.5 m high. *Young stems* silky-pubescent with short, pale, spreading hairs. *Leaves* pliable but not soft, linear-oblong to oblong-lanceolate, subacute to acuminate to obtuse, 2–4 cm long, 0.3–0.6 mm wide, (sparsely) silky-pubescent on the undersurface when young, the hairs c. 0.7 mm long, pale, spreading, the midvein obscure, the margins recurved to revolute. *Buds* (sparsely) silky-pubescent, the hairs 0.4–1 mm long, pale. Figure 2.

FLOWERING PERIOD: Late December to April.

HABITAT: Heath and dry sclerophyll eucalypt forest with a shrubby scleromorphic understorey, on shallow sandy soils derived from (Triassic) Hawkesbury Sandstone.

DISTRIBUTION: From the Robertson area south to the Shoalhaven River and west to the Wingello–Penrose area. (Figure 1).

CONSERVATION STATUS: not rare.

NOTES: In the Penrose-Wingello area, *P. mollis* subsp. *ledifolia* intergrades with subsp. *livens*. These plants have narrow-oblong to linear leaves, morphologically intermediate between the two subspecies. They seem to be confined to the same dry sclerophyll eucalypt forest on Hawkesbury Sandstone in which subsp. *ledifolia* is found. *P. mollis* subsp. *livens*, however, does not occur on (Triassic) Hawkesbury Sandstone. Rather it is found on older (upper Ordovician) undifferentiated sediments. This suggests that these intermediates have a closer affinity to subsp. *ledifolia* than to subsp. *livens*.

This subspecies possibly also intergrades with subsp. *nectens* (see under that subspecies).

In the southern extent of its range it does not seem to come into contact with subsp. *leptophylla*, nor to the west with subsp. *revoluta*.

Selected specimens: New South Wales: Central Coast: Illawarra, *Shepherd*, – (NSW 21327); top of ridge, Woodhill, 5 miles [9 km] from Berry, *Rodway*, 8 Jun 1930 (NSW 38783, K); road from Cambewarra Mtn to Berry Mt, *Maiden*, Sep 1905 (NSW 21326); top of Kangaroo Mtn, *Cambage 1317*, Sep 1905 (NSW). Central Tablelands: above Minnamurra Falls, *Judd*, 23 Apr 1954 (NSW 40160); East Kangaloon, c. 3 km NNW of Robertson, *Coveny 931*, 28 Feb 1969 (NSW); Robertson–Burrawang water supply reserve, at the locked gate, 34°33'S 150°35'E, *Weston 412*, 8 Jul 1984 (NSW); Barren Grounds Nature Reserve, at the carpark, 34°40'S 150°47'E, *Krauss 204*, 17 Feb 1990 (NSW, AD, B, BRI, CANB, CBG, HO, K, MEL, MO, NBG, PERTH, RSA); Jamberoo Mtn, on mountain road to Robertson, *N.W. Rodd*, 27 Jan 1950 (NSW 21325, CBG); Fitzroy Falls, *Garden*, Feb 1950 (NSW 21336); NE corner of E. Demuth's property (lot 167), Jamberoo Mountain Rd, Carrington Falls, 34°37'S 150°40'40"E, *Weston 1389 & Bishop*, 7 Apr 1989 (NSW 214242); Carrington Falls, *Constable*, 22 Jan 1955 (NSW 32230); Bundanoon, *Constable*, 7 Jan 1950 (NSW 11357).

P. mollis subsp. *ledifolia* – *P. mollis* subsp. *livens* intergrades:

Specimens examined: New South Wales: Central Tablelands: Sandy Creek, 15 km (direct) S of Moss Vale (on Meryla side), 34°40'S 150°23'E, *Johnson 8357*, 16 Oct 1977 (NSW); Garbutt's area, Meryla State Forest, *McGillivray*, 26 Feb 1959 (NSW 85109); Penrose, *Burgess*, 8 Nov 1968 (NSW, ex CBG 025751); Penrose, *Constable*, 22 Jan 1956 (NSW 36569); Wingello State Forest, *Constable*, 21 Jan 1956 (NSW 36565); Goulburn–Bungonia, *Moore 2738*, 20 Oct 1953 (NSW); Goulburn district, *Moore*, Feb 1865 (NSW 21525).

5. Persoonia mollis *R. Br.* subsp. **revoluta** *(Sieber ex Schultes & Schultes f.) S. Krauss & L. Johnson* **comb. et stat. nov.**

Basionym: *Persoonia revoluta* Sieber ex Schultes & Schultes f.
Schultes and Schultes (1827: 272).

Type citation: Nova Hollandia, *Sieber*, Fl. Nov. Holl. no. 48, 1825.

Lectotype (here designated): New South Wales: Nova Hollandia no. 48, *Sieber*, 1825 (B). Possible isolectotype: Nova Hollandia no. 48, *Sieber* (K, not seen).

Linkia revoluta (Sieber ex Schultes & Schultes f.) Kuntze (Kuntze 1891: 579).

Prostrate, spreading shrub, 10–50 cm high, up to 4 m diam.. *Leaves* glossy-green, pliable but not soft, almost fleshy, elliptical to oblong-ovate to oblong-lanceolate, obtuse (to rarely acute), 2.5–4 cm long, 4–10 (–15) mm wide, sparsely silky-pubescent to glabrous on the undersurface when young, the longest hairs c. 0.7 mm long, the midvein obscure or (rarely) prominent, the margins revolute. *Buds* sparsely silky-pubescent to ± glabrous, the hairs 0.3–1 mm long, pale. Figure 2.

Flowering period: Late December to early March (and then sporadically until April).

Habitat: Dry sclerophyll eucalypt forest (*E. sclerophylla*) with a shrubby scleromorphic understorey on deep grey-white sand (apparently not usually on skeletal soils) over (Triassic) Hawkesbury Sandstone.

Distribution: Occurs sporadically in a restricted area west of Mittagong to Bullio, and south to Berrima and Canyonleigh (Figure 1).

Conservation status: 2Ri (according to the coding system given in Briggs & Leigh (1988)).

Notes: Although apparently parapatric, this subspecies should perhaps be considered as allopatric. Although it borders three other *P. mollis* subspecies (subsp. *nectens*, subsp.

ledifolia, and subsp. *livens*), neither actual contact nor intermediates between these three subspecies and subsp. *revoluta* have been found. The low, spreading habit and bright green foliage give subsp. *revoluta* a very distinctive appearance, though it shares the general characters of *P. mollis* as here treated.

Selected specimens: New South Wales: Central Tablelands: Mittagong, *Dixon*, – (NSW 21335); Mittagong, *Baker*, Jan 1903 (NSW); Soapy Flat Rd, 3.3 km NW of Wombeyan Caves Rd, 34°23'40"S 150°20'50"E, *Weston 1418 & Krauss*, 18 Dec 1989 (NSW); Wombeyan Caves Rd, at junction of road to Kanangra property, 34°23'S 150°18'E, *Krauss 237 & Johnson*, 19 Apr 1990 (NSW); High Range, W of Mittagong, *Cosh*, late 1972? (NSW 127932); Bullio, *Burgess*, 25 Feb 1962 (NSW 56996); near Bungadilly, c. 11 miles [18 km] directly WNW of Berrima, *McGillivray 1541*, 11 Dec 1965 (NSW); 'Craigenbrae', c. 20 km W of Hume Hwy on Canyonleigh Rd, *Richards 128, Armstrong & Millar*, 17 Feb 1990 (NSW).

6. Persoonia mollis *R. Br.* subsp. **leptophylla** *S. Krauss & L. Johnson*, **subsp. nov.**

Frutex compactus 0.5–1.5 m altus, indumento sericeo-pubescenti ad maturitatem sparso, foliis laetevirentibus rigidis lineari-filiformibus vel filiformibus 1.5–4 cm longis 0.08–0.2 cm latis marginibus valde revolutis.

Holotype: New South Wales: Southern Tablelands: 5.8 km E of Tianjara Falls on the Nowra to Nerriga road, 35°06'S 150°16'E, *S. Krauss 205*, 17 Feb 1990 (NSW).
Isotypes: AD, B, BRI, CANB, CBG, CHR, DNA, HO, K, MEL, MO, NBG, PERTH, RSA.

Persoonia linearis Andr. var. *sericea* Benth. (Bentham 1870: 397).
Holotype: New South Wales: Shoalhaven River, *C. Moore*, May 1867 (K, photo).

Small to medium–sized, erect, branching but compact shrub 0.5–1.5 m high. *Young stems* silky-pubescent. *Leaves* bright green, rigid, linear-filiform to linear, truncate to acute, 1.5–4 cm long, 0.08–0.2 mm broad, sparsely villous to villous on the undersurface when young and often also when mature, the hairs c. 0.7 mm long, pale, closely appressed to the leaf undersurface, the midvein obscure, the margins extremely revolute to the extent that on dried specimens the undersurface is wholly or partly obscured. *Buds* (sparsely) silky-pubescent, the hairs 0.3–1 mm long, weakly spreading. Figure 2.

Derivation of epithet: From the Greek *leptos*, slender, and *phyllon*, a leaf; referring to the very narrow leaves.

Flowering period: Late December to May (and then sporadically until July).

Habitat: Dry sclerophyll eucalypt forest with a dense scleromorphic shrubby understorey, open eucalypt woodland with a scrubby or heathy understorey, and tall and low (coastal) heath, on shallow sandy soils derived from (Permian) Nowra Sandstone and (Permian) Conjola Formation sandstone on Beecroft Peninsula.

Distribution: Southern Morton National Park area, south of the Shoalhaven River, east of Nerriga, north of the Budawangs, and west of Nowra, with a disjunct occurrence on Beecroft Peninsula (Figure 1).

Conservation status: not rare.

Notes: In the Jervis Bay area *P. mollis* subsp. *leptophylla* intergrades with subsp. *caleyi*. The variation in this area can also be interpreted as being part of a greater (but not uniform) cline extending from the higher altitudes in the Sassafras area to the coast at Jervis Bay and then south to Durras Lake. Morphologically, the leaves of subsp. *leptophylla* are shortest on those plants just west of Sassafras. They gradually become longer with lower altitude towards Jervis Bay, although through this part of the cline

they remain as narrow as those at Sassafras (i.e. the undersurface of the leaf is not visible on dried specimens because of the revolute margins, although on living material they are not as inrolled). Extending south from Jervis Bay (subsp. *caleyi*), the trend is for leaves to be longer, and also broader, (i.e. with undersurface of leaves visible on dried specimens) so that at the southern extent of the range (Lake Durras) the leaves are almost lanceolate. In this regard, the boundary between these two subspecies appears somewhat arbitrary. The distinction drawn here correlates with a distinction in the substrate (subsp. *leptophylla* is almost restricted to Nowra Sandstone, subsp. *caleyi* is found only on Conjola Formation sediments). Other ecological factors such as habitat (vegetation) and rainfall possibly also correlate with the distribution of these two subspecies, although these need to be further investigated.

The locality of one specimen (Georges River, *Deane*, NSW 22020), is probably incorrect. This specimen is clearly subsp. *leptophylla*, and was probably collected in the vicinity of Nowra.

Selected specimens: New South Wales: Central Coast: 1.7 miles [2.8 km] W along Illaroo Rd, Nowra (N side of the river), 34°52'S 150°35'E, *Coveny 3964 & Bisby*, 10 Mar 1972 (NSW); Nowra Nth., *Constable*, 8 Dec 1950 (NSW 16436); Burrier, Shoalhaven River, left bank, *Rodway*, Feb 1923 (NSW 38756). South Coast: Nowra, *Rodway*, 3 Mar 1934 (NSW 38755, K (Rodway 1268)); Falls Creek, *Rodway*, Feb 1923 (NSW 38740); c. 1.5 km from Currarong Rd along Lighthouse Rd to Pt Perpendicular, Beecroft Peninsula, 35°02'S 150°49'E, *Krauss 239*, 7 May 1990 (NSW); 1 km NE of Honeymoon Bay on road to Lighthouse Rd, Beecroft Peninsula, 35°03'S 150°48'E, *Krauss 241*, 8 May 1990 (NSW); 1 km from Lighthouse Rd on road to Beecroft Hill, Beecroft Peninsula, 35°04'S 150°51'E, *Krauss 244*, 8 May 1990 (NSW); Nowra to Sassafras, c. 10 miles [17 km] SW of Nowra, *Salasoo 3117*, 9 Jan 1966 (NSW 90217); Tianjara Falls, c. 35 km SW of Nowra on Nowra–Nerriga road, 35°07'S 150°20'E, *Krauss 212 & Howitt*, 7 Apr 1990 (NSW); 4 km along Twelve Mile Rd from the Nowra–Nerriga road, 35°09'S 150°21'E, *Krauss 214 & Howitt*, 7 Apr 1990 (NSW). Southern Tablelands: Nerriga, between Nerriga and Towga above The Jumps, *Walker 1145*, Oct 1963 (NSW 69307, ex CANB); 2 miles SSW of Ettrema Trig., near Dogleg Ck, Ettrema Plateau, *Johnson & Briggs 3011*, 15 Mar 1969 (NSW); near Ettrema Ck, *Olsen 2435*, 28 Jan 1975 (NSW); Mt Bulee, 7 miles [11 km] NE of Nerriga, Pigeon House Range, *Constable*, 28 Oct 1957 (NSW 46253); Nerriga, Nowra–Braidwood Rd, *Boorman*, Jan 1915 (NSW 20946); Nerriga–Braidwood Rd, E of Endrick River crossing, *Blaxell 103*, 8 Dec 1968 (NSW); Sassafras, 10 miles [17 km] NE of Nerriga, *Constable*, 9 Mar 1961 (NSW 53914); c. 17 miles E of Nerriga along Braidwood–Nowra Rd, 35°08'S 150°16'E, *Hartley 14272*, 25 Mar 1975 (NSW, ex CANB).

7. Persoonia mollis *R. Br.* subsp. **livens** *S. Krauss & L. Johnson*, **subsp. nov.**

Subspecie *leptophylla* similis sed foliis liventi–viridibus pagina inferiore dense villosa distinguitur.

Holotype: New South Wales: Southern Tablelands: Lower Boro, 28 km N of Braidwood, 35°10'S 149°16'E, *P. Kodela 4076*, Jan 1989 (NSW).

Isotype: CBG.

Small to medium-sized, erect, branching but compact, obconical shrubs 0.5–1.5 m high. *Young stems* silky-pubescent. *Leaves* grey-green, rigid, linear-filiform to linear, truncate to acute, 1.5–3 cm long, 0.08-0.2 cm broad, densely villous on the undersurface when young and often also when mature, the hairs pale, c. 0.5 mm long, closely appressed to the leaf undersurface, the midvein obscure, the margins extremely revolute to the extent that on dried specimens the undersurface is wholly or partly obscured. *Buds* silky-pubescent, the hairs c. 0.5 mm long, weakly spreading. Figure 2.

Derivation of epithet: From the Latin *livens*, becoming leaden-green, from the greyer-green appearance of the foliage in contrast to the brighter green of subsp. *leptophylla*. The 'i' is pronounced long; in the English pronunciation this is as in 'alive'.

Flowering period: Late December to March.

Habitat: In dry sclerophyll eucalypt woodland with an open shrubby scleromorphic understorey on pale sandy to stony loams derived from (Ordovician) meta-sediments or conglomerate.

Distribution: In an area roughly bounded by Penrose, Goulburn and Braidwood, west of the Sydney Basin sandstones.

Conservation status: not rare.

Notes: In the Penrose–Wingello area this subspecies hybridises with subsp. *ledifolia* (see under the latter subspecies).

Along the western edge of the Budawang Range subsp. *livens* is parapatric with subsp. *budawangensis*. This boundary apparently correlates with a geological boundary, although this needs to be confirmed. *P. mollis* subsp. *budawangensis* is apparently restricted to (Upper Devonian) Merimbula Formation sandstone, whereas subsp. *livens* occurs west of this formation. Three specimens housed at NSW, collected along this boundary, are morphologically intermediate between these two subspecies. Although more collections are needed, it seems likely that a narrow hybrid zone exists between the two.

Selected specimens: New South Wales: Central Tablelands: Hume Hwy, Paddys River Bridge, NE end of bridge on bank 50 m from bridge, 34°39'S 150°08'E, *Davies 424 & Mulcahy*, 7 Dec 1987 (NSW ex CBG); Penrose, *Blakely*, 2 Oct 1938 (NSW 21519); Wingello, *Boorman*, Feb 1901 (NSW 21520), Aug 1899 (NSW 20944); Barbers Creek, *Maiden*, Dec 1899 (NSW 21522); Tallong, *Forsyth*, Jan 1900 (NSW 21523). Southern Tablelands: top of Governors Hill, E side of Goulburn, on Hume Hwy, *Rodd 5425, Corbett & Wilson*, 12 Apr 1986 (NSW, K); Goulburn, *Moore*, Feb 1865 (NSW 21526); Tarago, *Froggatt*, Oct 1894 (NSW 21527); Church of Mayfield, c. 25 km N of Braidwood, 35°13'S 149°18'E, *Kodela*, Jan 1989 (NSW 228133); near Warri Bridge, Shoalhaven River, 13 km NNW of Braidwood, 35°20'S 149°44'E, *Adams 2381*, 7 Feb 1969 (NSW, ex CANB, K, L); Charlies [Charleys] Forest near Braidwood, *Boorman*, Mar 1909 (NSW 21517); Currockbilly Mt, near Braidwood, *Boorman*, Sep 1915 (NSW 21516).

P. mollis subsp. *budawangensis* – *P. mollis* subsp. *livens* intergrades:

Specimens examined: New South Wales: Southern Tablelands: 15.6 km SW of Nerriga on Nerriga–Braidwood road, c. 700 m N of Charleys Forest Rd, 35°14'S 150°02'E, *Krauss 233 & Howitt*, 9 Apr 1990 (NSW); c. 1 km S of Nerriga–Braidwood road on Charleys Forest Rd, 35°15'S 150°02'E, *Krauss 232 & Howitt*, 9 Apr 1990 (NSW); foot of Mt Currockbilly, 50 miles [80 km] SW of Nowra, *Rodway*, 29 Jan 1940 (NSW 38776).

8. Persoonia mollis *R. Br.* subsp. **caleyi** *(R. Br.) S. Krauss & L. Johnson*, **comb. et stat. nov.**

Basionym: *Persoonia caleyi* R. Br.
(R. Brown 1830: 13).

Lectotype (here designated): Jervis Bay, *G. Caley*, Mar 1801 (BM). This sheet contains four elements. The two on the left (top and bottom) are Caley specimens. The two on the right (middle and far right) were collected by Baxter, the location given being Wilsons Promontory. This location is virtually certain to be incorrect, as the known southern limit of *P. mollis* is Lake Durras. These two elements were probably collected from the Jervis Bay area, as they are morphologically somewhat intermediate between subsp. *caleyi* and subsp. *leptophylla*. Of the two Caley elements, the top one is probably subsp. *leptophylla*. The bottom left element agrees well with the diagnosis and is clearly subsp. *caleyi* (as here defined), and is therefore here designated the Lectotype.

Linkia caleyi (R. Br.) Kuntze (Kuntze 1891: 579).

Medium to tall, erect, branching shrub 1.5–4 m high. *Young stems* silky-pubescent. Leaves ± soft, linear-lanceolate to narrow-lanceolate, acute, 3–6 cm long, 0.2–0.6 cm broad, (sparsely) silky-pubescent on the undersurface when young, the hairs pale, spreading, up to c. 0.7 mm long, the midvein obscure, the margins recurved to revolute. *Buds* sparsely silky-pubescent, the hairs 0.1–1 mm long, spreading. Figure 2.

Flowering period: Late December to July (occasionally later).

Habitat: Dry and wet sclerophyll forest with a shrubby scleromorphic or mesomorphic understorey, on sandy soil derived from (Permian) Conjola Formation sediments and Wandrawandian Siltstone.

Distribution: South Coast, south from Currumbene State Forest (Jervis Bay) to Durras Lake (Figure 1).

Conservation status: Not rare.

Notes: *P. mollis* subsp. *caleyi* intergrades with subsp. *leptophylla* along a hybrid zone roughly from the Huskisson area extending south-west to the Mt Tianjara area. This hybrid zone appears to correlate with the geological division between Nowra Sandstone and Conjola Formation/Wandrawandian Siltstone. However, more collections are needed to clarify the situation. See also under subsp. *leptophylla*.

It is not known whether subsp. *caleyi* comes into contact with subsp. *budawangensis* in the area south of Mt Tianjara, but it may do so. More collections are needed from this area.

The locality of one specimen (Moruya, *Baeuerlen*, Aug 1890 (NSW)), is most probably incorrect in a strict sense. The known southern limit of this subspecies is Lake Durras (this corresponding to the southern limit of the Conjola Formation sediments). This specimen is subsp. *caleyi*, but was probably collected north of Lake Durras.

Similarly, a specimen held at MEL (Mt Kaye, East Gippsland, Victoria, *Cane*, 30 Dec 1977 (MEL 522360, photo)), is almost certainly incorrect in its collecting locality. This specimen is subsp. *caleyi*, and was probably collected north of Lake Durras. *P. mollis* has not been otherwise recorded from the area of the supposed Gippsland locality, despite searches subsequent to this collection.

Selected specimens: New South Wales: South Coast: Currarong Rd, c. 2 km E of Princes Hwy, c. 8 km SSE of Nowra, 34°58'S 150°37'E, *Krauss 238*, 7 May 1990 (NSW); Currarong Rd, 1.2 km W of Coonemia Rd turnoff, c. 15 km (direct) SE of Nowra, 34°59'S 150°44'E, *Krauss 245*, 8 May 1990 (NSW); 3 miles [4.8 km] SW of Jervis Bay by road on the Cave Beach Rd, 35°09'S 150°41'E, *Coveny 3694*, 12 Oct 1971 (NSW); Jervis Bay, *Maiden*, Jul 1899 (NSW 20945); 1.2 km along walking track from Steamers Beach, *Richards 114, Makinson, Porteners, Mackay & Gross*, 18 Jun 1989 (NSW); Sussex Inlet Heads, *Maiden*, Feb 1917 (NSW 21506); 10 km NW of Milton, 35°16'S 150°21'E, *Adams & Paijmans 3729*, 25 Mar 1981 (NSW, ex CANB); Pigeon House Mtn, 19 km W of Ulladulla, *Willis*, 2 May 1982 (NSW, ex MEL 610807); Tibbourie, Milton [=Tabourie], *Cambage 3512*, 28 Dec 1911 (NSW); SW outskirts of Ulladulla, at end of Deering St, 35°23'S 150°28'E, *Haegi 1768*, 10 Feb 1979 (NSW, K, PERTH); between Pretty Beach and Merry Beach (along power line track), *Wrigley*, 15 Apr 1968 (NSW, ex CBG 024201); 50 m from Princes Hwy along Bucks Rd, c. 7 km S of Termeil, *Krauss 227 & Howitt*, 8 Apr 1990 (NSW); c. 3 km W of Pebbly Beach on track to Princes Hwy, *Wheeler 43*, 18 May 1975 (NSW, ex CBG 059054, L); Cockwhy Creek, South Brooman State Forest, 27.4 km N of Batemans Bay, *Coveny 2920*, 29 Jul 1970 (NSW).

9. Persoonia mollis *R. Br.* subsp. **budawangensis** *S. Krauss & L. Johnson*, **subsp. nov.**

Subspecie *ledifoliae* similis sed tepalis brevioribus 7.5–10.5 mm longis (contra 9–11.5 mm) atque pilis alabastrorum et paginarum inferiorum foliorum novellorum brevior-

ibus (longissimis 0.2–0.6 mm longis, contra 0.4–1 mm) distinguitur. Distributio disjuncta est.

HOLOTYPE: NEW SOUTH WALES: Southern Tablelands: c. 4 miles [7 km] SW of Corang Peak, Budawang Range, *T.G. Hartley 14236*, 2 Feb 1974 (NSW).
ISOTYPE: CANB (not seen).

Small to medium, erect, branching shrub 1–2.5 m high. *Young stems* silky-pubescent with short, pale, spreading hairs. *Leaves* pliable but not soft, linear-oblong to oblong-lanceolate, subacute to acuminate to obtuse, 2–4 cm long, 0.3–0.6 mm wide, silky-pubescent on the undersurface when young, the hairs c. 0.4 mm long, pale, the midvein obscure, the margins recurved to revolute. *Buds* (sparsely) silky-pubescent, the hairs 0.2–0.6 mm long, pale. Figure 2.

DERIVATION OF EPITHET: Refers to the distribution of this subspecies, which is endemic in the Budawang Range.

FLOWERING PERIOD: Late December to early May.

HABITAT: Wet sclerophyll forest, open sclerophyll eucalypt forest, or eucalypt woodland, in exposed and sheltered sites on sandy soils derived from (Upper Devonian) Merimbula Formation sandstone, from 500 to 1100 m altitude.

DISTRIBUTION: Endemic to the Budawang Range.

CONSERVATION STATUS: Not rare.

NOTES: Although this subspecies strongly resembles subsp. *ledifolia*, it is quite separate geographically (separated by a distance of at least 60 km, with subsp. *leptophylla* occurring in the intervening area), and it is possible to distinguish it morphologically from the latter (see key).

For discussion of intermediates see under *P. mollis* subsp. *leptophylla*, *P. mollis* subsp. *livens*, and *P. mollis* subsp. *caleyi*.

SELECTED SPECIMENS: NEW SOUTH WALES: Southern Tablelands: Near Camp Rock, Endrick SF, SW of Sassafras, *Blaxell 87*, 7 Dec 1968 (NSW); Sally Creek, near Budawang Range, *Olsen 823*, 5 May 1968 (NSW); Valley of the Monoliths, 2 km N of summit of The Castle, c. 28 km WSW of Milton, 35°15'S 150°11'E, *Briggs 3542*, 23 Apr 1972 (NSW); c. 2 km W of Mt Corang along track to 'Wog Wog' station, northern Budawang Range, c. 32 km NE of Braidwood, 35°17'S 150°05'E, *Pullen 4986 & Storey*, 26 Sep 1973 (NSW); Bibbenluke Walls, northern Budawang Range, *Olsen 990*, 16 Feb 1969 (NSW 87957); Currockbilly Mtn, 14 miles [24 km] ENE of Braidwood, *Constable 6983*, 15 May 1966 (NSW); Currockbilly Mtn near Braidwood, *Boorman*, Mar 1909 (NSW 22012); summit area of Mt Budawang, c. 10 miles [16 km] ESE of Braidwood, *Craven 685*, 6 Dec 1965 (NSW, ex CANB, B, BH, CHR, G, K, L, MEL, US); on the road to Mt Budawang, 0.3 km from NPWS sign (in property), *Weston 91*, 6 Dec 1979 (NSW, ex SYD); Monga or Sugarloaf Mtn, near Braidwood, *Boorman*, Mar 1909 (NSW 22010); Kings Hwy, 11 miles [19 km] SE of Braidwood, *Adams 1923*, 30 Jun 1967 (NSW, ex CANB, K); Clyde Mtn, 10 miles [17 km] ESE of Braidwood, *Constable 6934*, 13 May 1966 (NSW); Braidwood to Batemans Bay, *Salasoo 3761*, 25 May 1970 (NSW).

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References

Bentham, G. (1870) *Flora Australiensis* vol. 5.

Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants 1988*, revised edition. Australian National Parks and Wildlife Service Special Publication 14.

Brown, R. (1810a) On the natural order of plants called Proteaceae. *Trans. Linn. Soc.* 10: 15–226.

Brown, R. (1810b) *Prodromus florae Novae Hollandiae et Insulae van-Diemen* vol. 1.

Brown, R. (1830) *Supplementum primum prodromi florae Novae Hollandiae: exhibens Proteaceas novas*.

Jacobs, S.W.L. & Pickard, J. (1981) *Plants of New South Wales* (Government Printer: Sydney).

Johnson, L.A.S. & Briggs, Barbara G. (1975) On the Proteaceae – the evolution and classification of a southern family. *Bot. J. Linn. Soc.* 70: 83–182.

Kuntze, C.E.O. (1891) *Revisio generum plantarum* vol. 2.

Meisner, C.F. (1856) Proteaceae. In A. de Candolle, *Prodromus systematis naturalis regni vegetabilis* vol. 14, part 1.

Schultes, J.A. & Schultes, J.H. (1827) *Mantissa in volumen tertium systematis vegetabilium* vol. 3.

Weston, Peter H. & Johnson, L.A.S. (1991) Taxonomic changes in *Persoonia* (Proteaceae) in New South Wales. *Telopea* 4(2): 249–306.

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Systematic studies in the eucalypts – 2 *

A revision of the gimlets and related species: *Eucalyptus* extracodical series *Salubres* and *Annulatae* (Myrtaceae)

L.A.S. Johnson & K.D. Hill

Abstract

Johnson, L.A.S. & Hill, K.D. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1990. Systematic studies in the eucalypts - 2. A revision of the gimlets and related species: Eucalyptus *extracodical series* Salubres *and* Annulatae *(Myrtaceae).* Telopea *4(2): 201–222.* A taxonomic revision of the gimlets (series *Salubres*) and related gimlet-like species (series *Annulatae*) is presented. Twelve species are described, six of them new (*E. jimberlanica, E. tortilis, E. terebra, E. creta, E. extensa, E. protensa*). A new name at new rank is provided for one species (*E. ravida*), and one new subspecies is described (*E. effusa* subsp. *exsul*). A classification is presented, with keys to subgroups and species.

Introduction

The vernacular name of 'gimlet' or 'gimlet gum' is applied to members of series *Salubres* (*Eucalyptus* L'Hérit., subgenus *Symphyomyrtus* section *Bisectaria* as defined by Pryor and Johnson 1971), which consists of two subseries, the gimlets proper (subseries *Salubrosae*, 8 species) and the closely related subseries *Effusosae* (1 species). Of rather similar appearance are the members of the series *Annulatae* (3 species), which share with the *Salubres* seed and bark characters that are probably synapomorphies. All species are confined to the south-west of Western Australia.

Names of sections, series and subseries used by us are intentionally published in a system (PJ) devised by Pryor & Johnson (1971) and external to the International Code of Botanical Nomenclature. This avoids the confusion created by formal recognition of 'series' and 'subseries' that were used by Maiden (1903–1933) in a loose and informal sense, and classifying according to particular organ sets rather than as taxa. Moreover, as explained previously by Pryor & Johnson (1971), it allows for clear application of names and categories. Since it has a perfectly clear formalism of its own, the term 'extracodical', rather than 'informal', is appropriate.

As in lists recently privately distributed to some eucalypt workers, subseries names here differ from those used by Pryor & Johnson in ending with '-osae'. This is because '-inae' previously used is a subtribal ending (International Code of Botanical Nomenclature, 1988, Art. 19.2).

First to be named of the species treated here was *E. annulata*, described by Bentham (1867), who placed it in series *Normales* subseries *Cornutae*, with several other species. This was followed by *E. salubris* F. Muell. in 1876, *E. campaspe* S. Moore in 1899 and *E. diptera* C. Andrews in 1904.

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* Number 1 in this series was published as L.A.S. Johnson & K.D. Hill (1990) New taxa and combinations in *Eucalyptus* and *Angophora* (Myrtaceae). *Telopea* 4(1): 37–108.

Maiden (1903–1933) recognised these four species, placing them in section *Macrantherae* subsection *Longiores* series *Non-Corymbosae*, with three in subseries 'Miscellaneous' and one (*E. annulata*) in subseries *Cornutae* (1925). He had sufficient detail on only one to include it in his seed classification (*E. salubris*, series *Lepidotae-Fimbriatae*, subgroup Af). He had also earlier (1919) recognised a variety (*E. salubris* var. *glauca* Maiden).

Blakely (1934) recognised the same four species, but placed them in four widely separated groups (*E. annulata* in section *Macrantherae* series *Cornutae*, *E. campaspe* in the same section, series *Obliquae*, *E. diptera* in the same section, series *Dumosae* subseries *Dipterae*, and *E. salubris* with its variety *glauca* in section *Platyantherae* series *Contortae*).

Pryor & Johnson (1971) recognised these four species plus one unpublished, grouping all except *E. annulata* in their series *Salubres*. *E. annulata* was placed with a number of other species in their series *Occidentales*.

Chippendale (1988) followed Pryor & Johnson, but used different series names, placing the first group in series *Contortae* (after Blakely) and *E. annulata* in series *Micromembranae* (after Maiden 1925). He recognised the same five species as Pryor & Johnson, the fifth species having by then been published, viz. *E. effusa* Brooker.

Brooker and Kleinig (1990) recognised six species in series *Salubres*, two of them undescribed (species G and H, described below as *E. terebra* and *E. creta* respectively). They recognised the distinctive nature of *E. annulata*, leaving it as an unplaced anomalous species.

We now consider these taxa and their hitherto undescribed relatives to constitute a probable clade within the large section *Bisectaria* of the subgenus *Symphyomyrtus*, this clade consisting of two distinctive subclades each of which can be circumscribed and reasonably treated as a series.

The names applied to series and subseries by earlier authors are cited above merely to indicate the way in which those authors grouped the species concerned. Nothing is implied about their standing, since we are using only the PJ extracodical system between genus and species. The series mentioned below are constituted as in the modified PJ system circulated by us as indicated above.

Section Bisectaria

Bisectaria is the largest section in subgenus *Symphyomyrtus*, comprising about 270 taxa (species and subspecies). The vast majority are restricted to the Mediterranean climatic region of south-western Western Australia, which is clearly the centre of origin and diversification for the group (although probably not possessing a 'Mediterranean' climate earlier in the history of the group). The deduced relationships of the taxa at the various levels lead strongly to the conclusion that the arid zone and eastern regions have been separately colonised on several occasions by members of different series, and several radiation and isolation events can be postulated (Hill 1989).

The section is characterised as follows: Cotyledons deeply bisected, varied in size and shape. Pith glands present or absent. Bark glands absent. Adult leaves amphistomatic (hypostomatic in *E. dundasii*). Phyllotaxis disjunct, opposite or (exceptionally and secondarily) spiral. Calyx calyptriform, free from corolla, shedding early in bud development (persistent to anthesis in subseries *Caesiosae*). Anthers versatile or adnate, highly varied in shape.

Prominent reticulation (i.e. veins at all grades raised above surrounding leaf surface) in early seedling leaves is probably a plesiomorphic character in *Bisectaria*. This fea-

ture occurs in a number of series, in generally unspecialised taxa within the series. Examples are *Loxophlebae, Prominentes, Sociales, Macrocarpae,* and *Orbifoliae. Reduncae* and *Desmondenses* show prominence in only the main laterals, while *Salubres* and *Annulatae* show complete reduction in this feature.

Phylogenetic relationships of the series within *Bisectaria* remain to be clarified, although subgroups are generally clearly defined. One such distinct group is the pair *Salubres* plus *Annulatae,* treated here.

The series pair is characterised as follows: pith glands present; stomata small, green; cuticle smooth, glossy; anthers elongate, dorsifixed, versatile. Seeds irregular, ragged, deeply pitted; hilum ventral.

While most of these characters are probably plesiomorphic, the seeds are distinctive, and their characters are considered apomorphic conditions uniting the two series as sister groups. The distinctive smooth, glossy or subglossy brown or greenish new bark (aging to bronze or coppery) is also common throughout the two series, and most probably a synapomorphy (on the basis of outgroup comparison).

We are acquainted with all the taxa in the field.

Key to the series, subseries and species

1 Filaments erect in mature bud; stemonophore broad, overlying ovary top; disc narrow; oil glands in adult leaves spherical ..... Series **Annulatae**
2 Peduncle narrow ..... **12. E. protensa**
2* Peduncle broadly flattened
3 Buds less than 18 mm long, fruit sessile ..... **10. E. annulata**
3* Buds more than 17 mm long, fruit pedicellate ..... **11. E. extensa**
1* Filaments inflexed in mature bud; stemonophore narrow; disc broad; oil glands in adult leaves irregularly angular ..... Series **Salubres**
4 Mallees, bark persistent on trunk ..... Subseries **Effusosae** ..... **9. E. effusa**
4* Trees, bark smooth to base ..... Subseries **Salubrosae**
5 Plants glaucous
6 Buds 5–8 mm diam., fruit 8–10 mm diam. ..... **3. E. campaspe**
6* Buds 4–5 mm diam., fruit 4–7 mm diam. ..... **2. E. ravida**
5* Plants not glaucous
7 Inflorescences 7–flowered
8 Buds sessile ..... **6. E. terebra**
8* Buds pedicellate
9 Buds 4–5 mm diam., fruit 4–7 mm diam. ..... **1. E. salubris**
9* Buds 5–7 mm diam., fruit 6–8 mm diam.
10 Calyptra acute ..... **5. E. tortilis**
10* Calyptra hemispherical ..... **4. E. jimberlanica**
7* Inflorescences 3-flowered
11 Buds 7–9 mm diam., fruit 9–14 mm diam. ..... **7. E. diptera**
11* Buds 9–12 mm diam., fruit 15–21 mm diam. ..... **8. E. creta**

Series Salubres

Pith glands present. Stomata small, green. Cuticle smooth, glossy. Oil glands in adult leaves irregularly angular. Filaments inflexed in mature buds; anthers elongate, dorsifixed, versatile. Disc broad; stemonophore narrow. Seeds irregular, ragged, deeply pitted; hilum ventral.

In the series *Salubres*, the stemonophore is relatively narrow, the disc is broad and flat, the oil-glands of the adult (not juvenile) leaves have irregular laterally projecting angles, and are less densely packed than those of *Annulatae*, and the primary and secondary lateral veins of the leaves are more distinct.

The subseries *Effusosae* differs from the subseries *Salubrosae* in the mallee habit and partly persistent bark. The smooth bark is comparable to the smooth bark of the other gimlets.

Subseries Salubrosae

Trees. Bark smooth to base.

The eight species of this group are the 'gimlets' proper, so named because of the characteristic irregular often spiralled fluting of the trunk caused by non-uniform development of the wood. All species typically form small dense pure stands on strongly calcareous soils, often over greenstones (low-grade metamorphosed basic or ultrabasic igneous rocks). These stands characteristically include a low shrubby understorey of calcicole species such as *Cratystylis conocephala*, *Atriplex* and some *Melaleuca* species. Gimlet stands tend to occur on low but not swampy sites in the south of the range of the group, and more on low rises further to the north. This difference sometimes involves different gimlet species, although widespread taxa such as *E. salubris* and *E. ravida* follow the same pattern within their ranges.

Intergrading populations and some occasional hybrid individuals occur in places where the species meet, and are listed later under the various species involved (specimens of intergrading populations and hybrids are cited on p. 78 and distributions are given in Figure 13). There are however also many sites where gimlet taxa are sympatric and show no breakdown. This occurs over a wide area with *E. salubris* and *E. ravida*, with the two forming a fine mosaic rather than occurring in mixed stands. A similar pattern occurs with *E. ravida* and *E. terebra*, and *E. terebra* and *E. creta* occur in mixed stands with no apparent breakdown in the east of the range of the latter. No hybrids are recorded with taxa from other series or subseries apart from the one *Annulatae–Salubres* hybrid known.

1. Eucalyptus salubris *F. Muell.*, Fragm. 10: 54 (1876).

TYPE CITATION: 'Inter Victoria-Spring et Ularing; Young.'

TYPE: WESTERN AUSTRALIA: between Victoria Spring and Ularing, *J. Young*, 9 Oct 1875 (holo MEL; iso K).

Tree to 20 m high, rarely 25 m, branches erect and arising near base. *Bark* smooth throughout, glossy dark green-brown or bronze to brilliant copper. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, glossy green, 4.5–10.5 cm long, 0.7–1.8 cm wide; petioles 8–15 mm long; lateral veins moderately spaced, regular, at 30°–40° to midrib; intramarginal vein continuous, ± distinct, to 1 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, flattened, 4–14 mm long, to 4 mm wide apically; pedicels angular, 1–5 mm long. *Mature buds* ovoid, 7–12 mm long, 4–5 mm diam.; calyptra rounded or convex-conical, obtuse, about as long as or slightly longer than hypanthium. *Fruits* obconical to cup-shaped, often 2-winged, 3–4-locular, 3–7 mm long, 4–7 mm diam.; disc slightly raised or flat, ± incurved ultimately, 0.5–1.5 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically exserted, raised at 45°–90°.

This species is distinguished by the non-glaucous branchlets, the 7-flowered umbellasters, and the small, pedicellate fruit.

A widespread and common species in the northern and eastern wheat belt and eastwards, from between Morawa and Kondinin in the west to between Lake Minigwal and the Fraser Range in the east (Avon, Roe and Coolgardie Districts of Beard, 1980) (Figure 1).

While this species occurs in the characteristic small pure stands of most gimlet species as mentioned earlier, extensive open woodlands with admixed *E. oleosa* also occur in the region west and north-west of Norseman.

Intergrading populations are known with *E. ravida*, *E. tortilis* and *E. diptera*.

SELECTED SPECIMENS (from 47 examined): WESTERN AUSTRALIA (W to E): 5.2 miles [83.2 km] SSE of Maya, *Chippendale 58*, 21 Oct 1966 (NSW); 64 km SW of Paynes Find, *Brooker 8717*, 18 Oct 1984 (NSW); 13 km NW of Yoting, *Crisp 5509*, 27 Jan 1979 (NSW); 20.5 km N of Tammin on Wyalkatchem road, *Johnson 9205 & B. Briggs*, 02 Nov 1988 (NSW, CANB, PERTH); Kununoppin, *Stoward 205*, Nov 1917 (NSW); Kondinin, *Stoward 56*, Jan 1917 (NSW); 22 km E of Merriden, *Beadle 93*, 25 May 1972 (NSW); Carrabin, *Coveny 8348*, 12 Sep 1976 (NSW); 0.6 miles [1 km] E of Bodallin, *Chippendale 94*, 6 Mar 1967 (NSW); 17 miles [27 km] from the Humps towards King Rocks, *Wrigley*, 10 Nov 1968 (NSW); 1 mile [1.6 km] W of Bullfinch, *Phillips*, 18 Sep 1962 (NSW); 19.6 km N of Diemals on Youanmi road, *Hill 2611 & Johnson*, 25 Nov 1986 (NSW, PERTH); 2.9 km E of rabbit-proof fence on Varley - Southern Cross road, *Hill 3049*, 1 Sep 1988 (NSW); 22 km SSW of Coolgardie to Gnarlbine Rock, *Crisp 5615*, 31 Jan 1979 (NSW); 9 miles [16.4 km] N of Bullabulling, *Fitzgerald*, Nov 1903 (NSW); 76.8 km W of Coolgardie-Norseman road on Hyden track, *Hill 614, Johnson & Blaxell*, 7 Nov 1983 (NSW); Mount Jessop, 9.6 km W of Kookynie, *Hill 527, 528, Johnson & Blaxell*, 4 Nov 1983 (NSW); 8 miles [12.5 km] N of Kalgoorlie, *Speck 900*, 5 July 1958 (NSW); 32 km N of Kambalda, *Brooker 6402*, 21 Aug 1979 (NSW); 21.1 km S of Widgiemooltha, *Brooker 6408*, 21 Aug 1979 (NSW); 15.3 km N of Norseman, *Hill 586, Johnson & Blaxell*, 6 Nov 1983 (NSW); 92 km E of Norseman on highway, *Hill 2213 & Johnson*, 4 Nov 1986 (NSW, CBG, CANB, MEL, PERTH); S side Lake Minigwal, *Brooker 8597*, 16 May 1984 (NSW); 0.3 km N of roundabout 51.1 km N of Mulga Rock on Lake Minigwal track, *Hill 2673 & Johnson*, 29 Nov 1986 (NSW, PERTH).

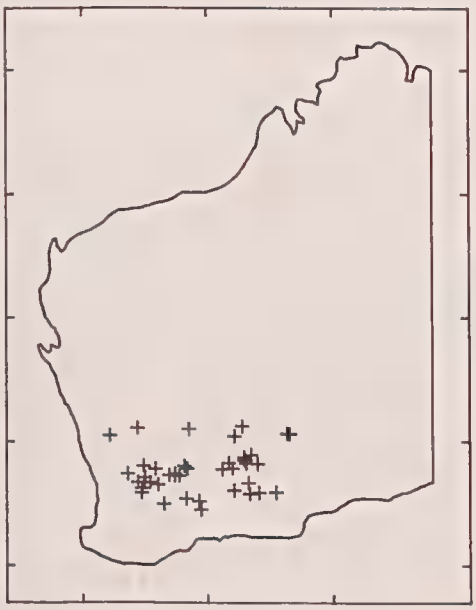

Figure 1. Distribution of *E. salubris*.

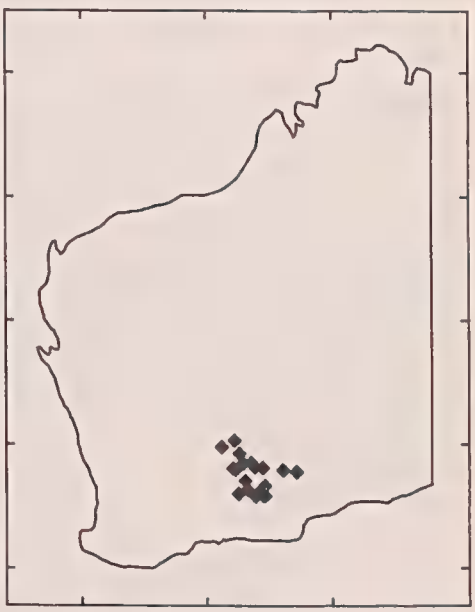

Figure 2. Distribution of *E. ravida*.

2. Eucalyptus ravida *L. Johnson & K. Hill*, **nom. et stat. nov.**

REPLACED NAME: *E. salubris* F. Muell. var. *glauca* Maiden, Crit. Revis. Eucalyptus 4: 158 (1919).

TYPE CITATION: 'Trees 70 miles north of Kurrawang (J.H.M.) are wholly glaucous and with sessile inflorescence.'

TYPE: WESTERN AUSTRALIA: 70 miles [112 km] N of Kurrawang, *J.H. Maiden*, Sep 1909 (holo NSW; iso CANB).

Tree to 20 m high, branches erect and arising near base. *Bark* smooth throughout, glossy dark green-brown or bronze to coppery; young branches strongly white-glaucous before bark first sheds. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, strongly glaucous when young, soon weathering to glossy green, 4.5–10.5 cm long, 0.7–1.8 cm wide; petioles 8–15 mm long; lateral veins moderately spaced, regular, at 30°–40° to midrib; intramarginal vein continuous, ± distinct, to 1 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, flattened, 4–14 mm long, to 7 mm wide apically; pedicels angular, 0–2 mm long. *Mature buds* ovoid, strongly glaucous, 7–12 mm long, 4–5 mm diam.; calyptra rounded or convex-conical, obtuse, about as long as hypanthium. *Fruits* glaucous, obconical to cup-shaped, often 2-winged, 3–4-locular, 3–7 mm long, 4–7 mm diam.; disc slightly raised or flat, ± incurved ultimately, 0.5–1.5 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically exserted, raised at 45°–90°.

NOTE: Included in *E. salubris* by Pryor & Johnson (1971).

Distinguished within the subseries by the strongly glaucous branchlets, the 7-flowered umbellasters, and the small, pedicellate buds and fruit.

A common species in the central Goldfields districts, from Callion south to Norseman and east to Zanthus (Coolgardie and Eucla Districts) (Figure 2).

Intergrading populations with *E. salubris* are known and hybrids with *E. tortilis* are recorded.

The epithet is from the Latin *ravidus*, greyish, from the appearance of the tree caused by the glaucous twigs and immature adult leaves.

SELECTED SPECIMENS (from 27 examined): WESTERN AUSTRALIA (N to S): 2.9 km N of Callion on road, *Hill 2660 & Johnson*, 28 Nov 1986 (NSW, PERTH); 49 km N of Kalgoorlie, *Hill 548, Johnson & Blaxell*, 4 Nov 1983 (NSW); 6.6 miles [10.6 km] SW of Kalgoorlie, *Chippendale 113*, 8 Mar 1967 (NSW). 30 km E of Kalgoorlie, *Blaxell 1651*, 20 June 1978 (NSW); 4.7 miles [7.5 km] W of Curtin, *Chippendale 134*, 10 Mar 1967 (NSW); 52 km E of Karonie, *Hill 557, Johnson & Blaxell*, 5 Nov 1983 (NSW); 7 miles [11 km] E of Coolgardie, *Johnson W 162*, 17 Dec 1960 (NSW); 6.4 km S of turnoff near Zanthus on Balladonia track, *Hill 2695 & Johnson*, 30 Nov 1986 (NSW, PERTH); 2.6 miles [4.2 km] NNW of Widgiemooltha, *Chippendale 379*, 23 Mar 1968 (NSW); 40 miles [64 km] NW of Fraser Range, *Helms*, 5 Nov 1891 (NSW); 16 miles [26 km] N of Norseman, *Ralph*, 25 Oct 1973 (NSW); 36.4 km W of Coolgardie road on Hyden track, *Hill 608, Johnson & Blaxell*, 7 Nov 1983 (NSW); 4.2 miles [6.7 km] E of Norseman, *Baker 58*, 13 Nov 1970 (NSW); 60 km E of Norseman, *Hill 693 & Blaxell*, 14 Nov 1983 (NSW); 128.7 km W of Balladonia roadhouse on hwy, *Hill 2835*, 24 Aug 1988 (NSW).

3. Eucalyptus campaspe *S. Moore*, J. Linn. Soc., Bot. 34: 193 (1899).

TYPE CITATION: 'Hab. Ad Gibraltar mens. Oct. florescit.'

TYPE: WESTERN AUSTRALIA: Gibraltar, 16 miles [26 km] SW of Kalgoorlie, *S. Moore 95*, 1895 (holo BM, NSW; iso K, MEL). The fragment in NSW was sent to J.H. Maiden by

Moore, and was recorded as being a piece of the Holotype (Crit. Revis. Eucalyptus 2: 216).

Tree to 12 m high, branches erect and arising near base. *Bark* smooth throughout, yellow-brown to dark green-brown, bronze or reddish copper. *Adult leaves* disjunct, similifacial, lanceolate, acute or acuminate, strongly glaucous, dull, sometimes weathering to sub-glossy green, 7–12 cm long, 1–2 cm wide; petioles 10–15 mm long; lateral veins moderately spaced, regular, at 30°–40° to midrib; intramarginal vein continuous, ± distinct, to 1 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, flattened, 4–9 mm long, to 5 mm wide apically; pedicels angular, 1–4 mm long. *Mature buds* strongly glaucous, ovoid, 9–13 mm long, 5–8 mm diam.; calyptra hemispherical, about as long as hypanthium. *Fruits* strongly glaucous, hemispherical, often 2-winged, 3–4-locular, 6–9 mm long, 8–10 mm diam.; disc slightly raised or flat, ± incurved ultimately, 1–3 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically exserted, raised at c. 45°.

All parts strongly glaucous. Leaves mostly dull. Umbellasters 7-flowered. Buds large, rounded. Fruit large, almost sessile.

Restricted to the vicinity of Coolgardie and Kalgoorlie (Coolgardie District) (Figure 3).

E campaspe tends to occur more exclusively on ultrabasic rock outcrops than the other gimlet species.

Selected specimens (from 26 examined): Western Australia (N to S): 19.3 miles [30.1 km] SW of Kalgoorlie, Chippendale 117, 8 Mar 1967 (NSW); 7.5 km from Coolgardie to Kalgoorlie, *Hill 574, Johnson & Blaxell*, 6 Nov 1983 (NSW); 2 km N of Coolgardie, *Blaxell 1659*, 21 June 1978 (NSW); 1.2 miles [1.9 km] E of Coolgardie, *Baker 123*, 23 Nov 1970 (NSW); 7 miles [11 km] E of Coolgardie, *Johnson W 163*, 17 Dec 1960 (NSW); 2.6 miles [4.2 km] SE of Coolgardie, *Chippendale 138*, 11 Mar 1967 (NSW); 8 km S of Coolgardie, *Beadle 69*, 28 May 1972 (NSW); Comet Hill, on roadside 11.0 km S of Coolgardie, *Hill 2635 & Johnson*, 26 Nov 1986 (NSW, PERTH); 19 km SSW of Coolgardie, *Crisp 5616*, 31 Jan 1979 (NSW); 31.5 km SE of Coolgardie, *Brooker 7047*, 09 Nov 1981 (NSW).

Figure 3. Distribution of *E. campaspe*.

4. Eucalyptus jimberlanica *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: haud glauca; umbellastrae 7-florae; alabastra magna, rotundata; fructus magni, subsessiles.

TYPE: WESTERN AUSTRALIA: Jimberlana Hill, NE of Norseman, *K. Hill 599, L. Johnson & D. Blaxell*, 6 Nov 1983 (holo NSW).

Tree or mallee to 10 m high, branches erect and arising near base. *Bark* smooth throughout, glossy dark green-brown or bronze to coppery. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, glossy green, 4.5–9.0 cm long, 0.5–1.8 cm wide; petioles to 1.3 cm long; lateral veins moderately spaced, regular, at 30°–50° to midrib; oil glands large, stellate, moderately to sparsely distributed; intramarginal vein continuous, ± distinct, 0.3–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, flattened, 2–9 mm long, to 4 mm wide apically; pedicels angular, 1–2 mm long. *Mature buds* ovoid to globular, 7–10 mm long, 6–8 mm diam.; calyptra hemispherical, about as long as hypanthium or slightly longer. *Fruits* obconical to cup-shaped, often 2-winged, 4-locular, 7–9 mm long, 6–8 mm diam.; calyptra scar raised at ± 45°, 0.5–1.0 mm wide; stemonophore raised, 0.2–0.5 mm wide; disc slightly raised or flat, ± incurved ultimately, 0.5–1.0 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically exserted, raised at 30°–70°. Figure 4.

Distinguished within the subseries as follows: branchlets not glaucous, inflorescences 7-flowered, buds large, rounded, fruits large, almost sessile.

Known from a single small population near Norseman (Coolgardie District). No other gimlets are in the immediate vicinity (Figure 5).

The epithet refers to the only known locality.

SPECIMENS EXAMINED: WESTERN AUSTRALIA: W foot of Jimberlana Hill, NE of Norseman, *Hill 2838*, 24 Aug 1988 (NSW).

Figure 4. *E. jimberlanica*. **a**, adult leaves and buds. **b**, fruits (all from *Hill 2838*). Scale bar = 1 cm.

The following four species exhibit a geographic replacement pattern with overlap of *E. terebra* and *E. creta* in the southeast (Burgman 1985). Species of this group occur more on residual calcareous loams, whereas the previous species are found more on basic or ultrabasic outcrops.

5. Eucalyptus tortilis *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: haud glauca; umbellastrae 7-florae; alabastra magna, breviter pedicellata; calyptra longa, acuta; fructus longiores quam latiores.

TYPE: WESTERN AUSTRALIA: 52.2 km E of Norseman on Eyre Highway, (32° 03'S 122° 06'E), *K. Hill 688 & D. Blaxell*, 14 Nov 1983 (holo NSW; iso CANB, K, PERTH).

Tree or mallee to 10 m high, branches erect and arising near base. *Bark* smooth throughout, glossy dark green-brown or bronze to coppery. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, glossy green, 4.5–9.0 cm long, 0.5–1.8 cm wide; petioles to 1.3 cm long. *Lateral veins* moderately spaced, regular, at 30°–50° to midrib; oil glands large, stellate, moderately to sparsely distributed; intramarginal vein continuous, ± distinct, 0.3–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered. *Peduncles* thick, flattened, 2–9 mm long, to 4 mm wide apically. *Pedicels* angular, 1–2 mm long. *Mature buds* ovoid, 10–14 mm long, 5–7 mm diam.; calyptra convex, acute, 1.5–2 times as long as hypanthium. *Fruits* obconical to cup-shaped, often 2-winged, 4-locular, 7–9 mm long, 6–8 mm diam.; calyptra scar raised at ± 45°, 0.5–1.0 mm wide; stemonophore raised, 0.2–0.5 mm wide; disc slightly raised or flat, + incurved ultimately, 0.5–1.0 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically exserted, raised at 30°–70°. Figure 6.

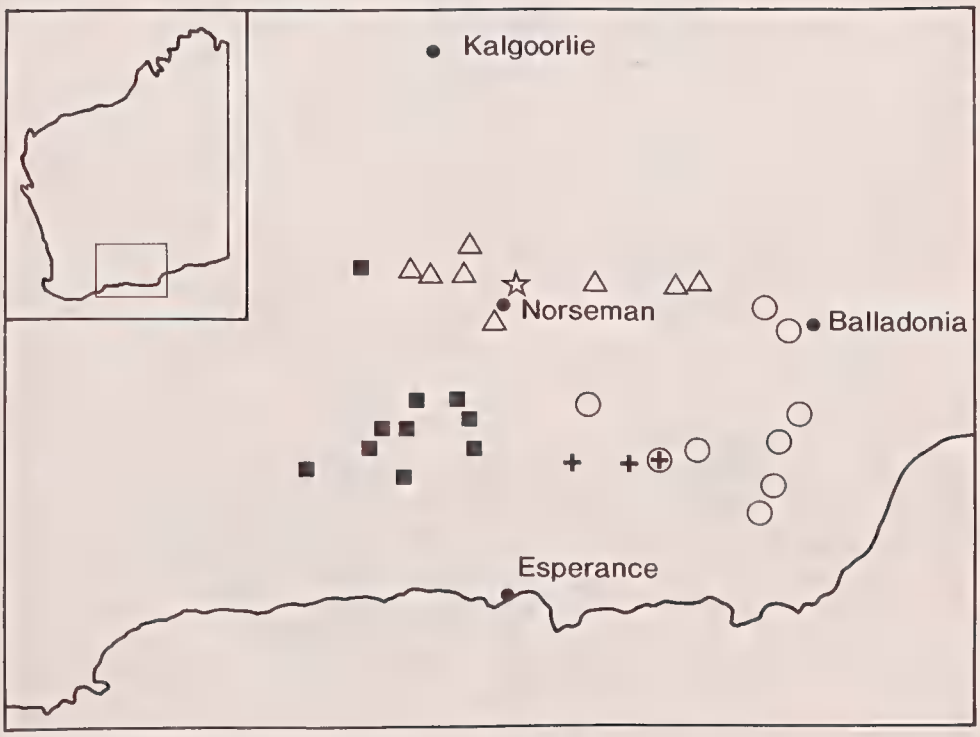

Figure 5. Distribution of *E. jimberlanica* (☆), *E. tortilis* (△), *E. terebra* (○), *E. diptera* (■) and *E. creta* (+).

Distinguished as follows: branchlets not glaucous; umbellasters 7-flowered; buds large, shortly pedicellate; calyptra long, acute; fruits longer than broad.

E. tortilis shows some approach to *E. salubris*, which is finer and more delicate in all parts.

Distributed from west of Norseman to the Fraser Range (Coolgardie District) (Figure 5).

Sporadic in distribution but locally abundant, usually in woodlands on calcareous loams, mostly on slightly elevated, level sites with a wide range of associated species.

Hybrids are recorded with *E. terebra* and *E. salubris*.

The epithet is from the Latin *tortilis*, twisted, referring to the 'gimlet' trunk.

SELECTED SPECIMENS (from 11 examined): WESTERN AUSTRALIA (W to E): 14.1 km W of Coolgardie-Norseman road on Hyden track, *Hill 602, Johnson & Blaxell*, 7 Nov 1983 (NSW); 7.6 km W of Coolgardie-Norseman road on Hyden track, *Brooker 8350*, 7 Nov 1983 (CANB, NSW, PERTH); 120 km S of Coolgardie along hwy, *Hill 583, L. Johnson & Blaxell*, 6 Nov 1983 (NSW); c. 20 km S of Norseman, *Blaxell 1670*, 21 June 1978 (NSW); 60 km E of Norseman, *Hill 691 & Blaxell*, 14 Nov 1983 (NSW); 130 km W of Balladonia, *Beadle 54*, 28 Oct 1972 (NSW); 128.7 km W of Balladonia roadhouse on hwy, *Hill 2836*, 24 Aug 1988 (NSW); 69 km W of Balladonia roadhouse, *Hill 228 & Johnson*, 19 Oct 1983 (NSW).

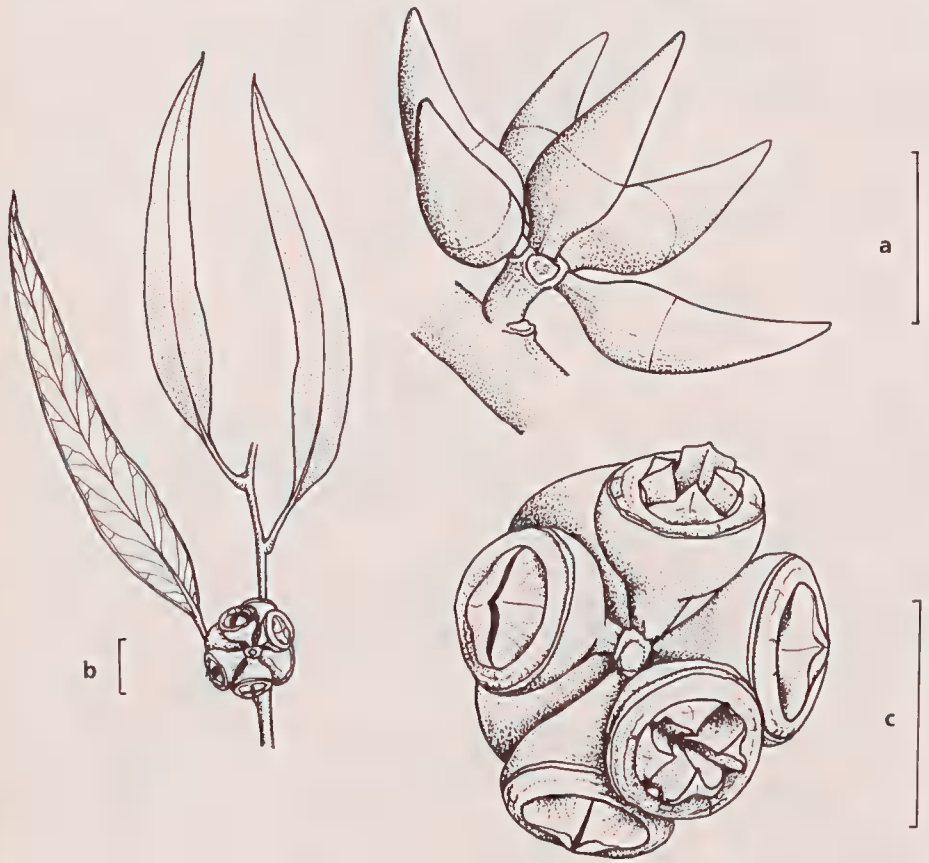

Figure 6. *E. tortilis*. **a,** buds. **b,** adult leaves and fruits. **c,** fruits (a from *Hill 688 & Blaxell*, b, c from *Chippendale* 50). Scale bar: a, b, c = 1 cm.

6. Eucalyptus terebra *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: haud glauca; umbellastrae 7-florae; fructus sessiles, latiores quam longiores.

Type: Western Australia: 16.7 km W of Balladonia Roadhouse along Highway 1 (32°16'S, 123°28' E), *K. Hill 210 & L. Johnson*, 19 Oct 1983 (holo NSW; iso CANB, PERTH, MEL, K).

Tree or sometimes mallee, to 11 m high. *Bark* smooth, shining, dark bronze or greenish brown to coppery. *Adult leaves* lanceolate or narrow-lanceolate, disjunct, acuminate, similifacial, distinctly glossy, 4–8 cm long, 0.5–1.1 cm wide; petioles 0.6–1.4 cm long; lateral veins irregular, widely spaced, at 30–45° to midrib; intramarginal vein distinct, 0.5–1 mm from margin; oil glands widely scattered, large. *Umbellasters* simple, axillary, 7-flowered; peduncles terete, 1–2 mm long. *Mature buds* sessile, globular, sometimes apiculate, 9–10 mm long, 7–8 mm diam.; calyptra as long as hypanthium or slightly longer. *Fruits* broadly hemispherical to campanulate, 4-locular, 6–8 mm long, 8–10 mm diam.; calyptra scar 1.0–1.5 mm wide, vertically raised, almost continuous with hypanthium; disc 1–2 mm wide, flat; valves broadly triangular, exserted, incurved. Figure 7.

Distinguished by the non-glaucous branchlets; the 7-flowered umbellasters; and the sessile fruits, which are much broader than long.

Locally common between the Fraser Range and Balladonia, south almost to Mt Heywood (Coolgardie and Roe Districts) (Figure 5).

Usually in dense but scattered stands in low woodland on calcareous sandy loams, associated with *E. oleosa*, *E. melanoxylon*, *E. flocktoniae*, *E. eremophila*, and *E. fraseri*.

The epithet is from the Latin *terebra*, a gimlet, used as a noun and not an adjective. The stress is best placed on the second 'e', pronounced long.

Selected specimens (from 16 examined): Western Australia (N to S): c. 15–20 km NW of Balladonia, *Brooker 6440*, 22 Aug 1979 (NSW); 4.4 km W of Balladonia, *Brooker 7480*, 28 Apr 1982 (NSW); 63.1 km S of Balladonia roadhouse, *Hill 236 & Johnson*, 20 Oct 1983 (NSW); Coragina Rock, *Beard 5282*, 27 Oct 1967 (NSW); 20 km E of 'Beard site', *Burgman*, 1983 (NSW); 51.4 km NE of Howick Road on survey track, *Hill 297 & Johnson*, 21 Oct 1983 (NSW); 30 miles [48 km] NE of Mt Ney, *Beard 6372*, 17 Sep 1970 (NSW); 30.7 km N of Israelite Bay turnoff at Mt Ragged on track to Balladonia, *Hill 3171*, 9 Sep 1988 (NSW); 7 miles [11 km] N of Pine Hill, *Brooker 4534*, 10 Apr 1974 (NSW).

7. Eucalyptus diptera *C. Andrews*, J. Proc. Mueller Bot. Soc. Western Australia 1: 42 (1904).

Type citation: 'I found this species in flower north of Esperance, in October 1903.'

Type: Western Australia: N of Esperance, *C. Andrews*, Oct 1903 (holo PERTH; iso NSW).

Tree or sometimes mallee, to 10 m high. *Bark* smooth, shining, dark bronze or greenish brown to coppery. *Adult leaves* lanceolate or narrow-lanceolate, disjunct, acuminate, similifacial, distinctly glossy, 6–9 cm long, 0.8–1.5 cm wide; petioles 0.6–1.4 cm long; lateral veins irregular, widely spaced, at 30–45° to midrib; intramarginal vein distinct, 0.5–1 mm from margin; oil glands widely scattered, large, stellate. *Umbellasters* simple, axillary, 3-flowered; peduncles terete, 1–2 mm long. *Mature buds* sessile, globular to ovoid, apiculate, 2-winged, 9–13 mm long, 7–10 mm diam.; calyptra as long as hypanthium or slightly longer. *Fruits* broadly hemispherical to campanulate, 2-winged, 4-locular, 7–10 mm long, 9–15 mm diam.; calyptra scar 1–2 mm wide, vertically raised, almost continuous with hypanthium; disc 1–2 mm wide, flat; valves broadly triangular, exserted, incurved.

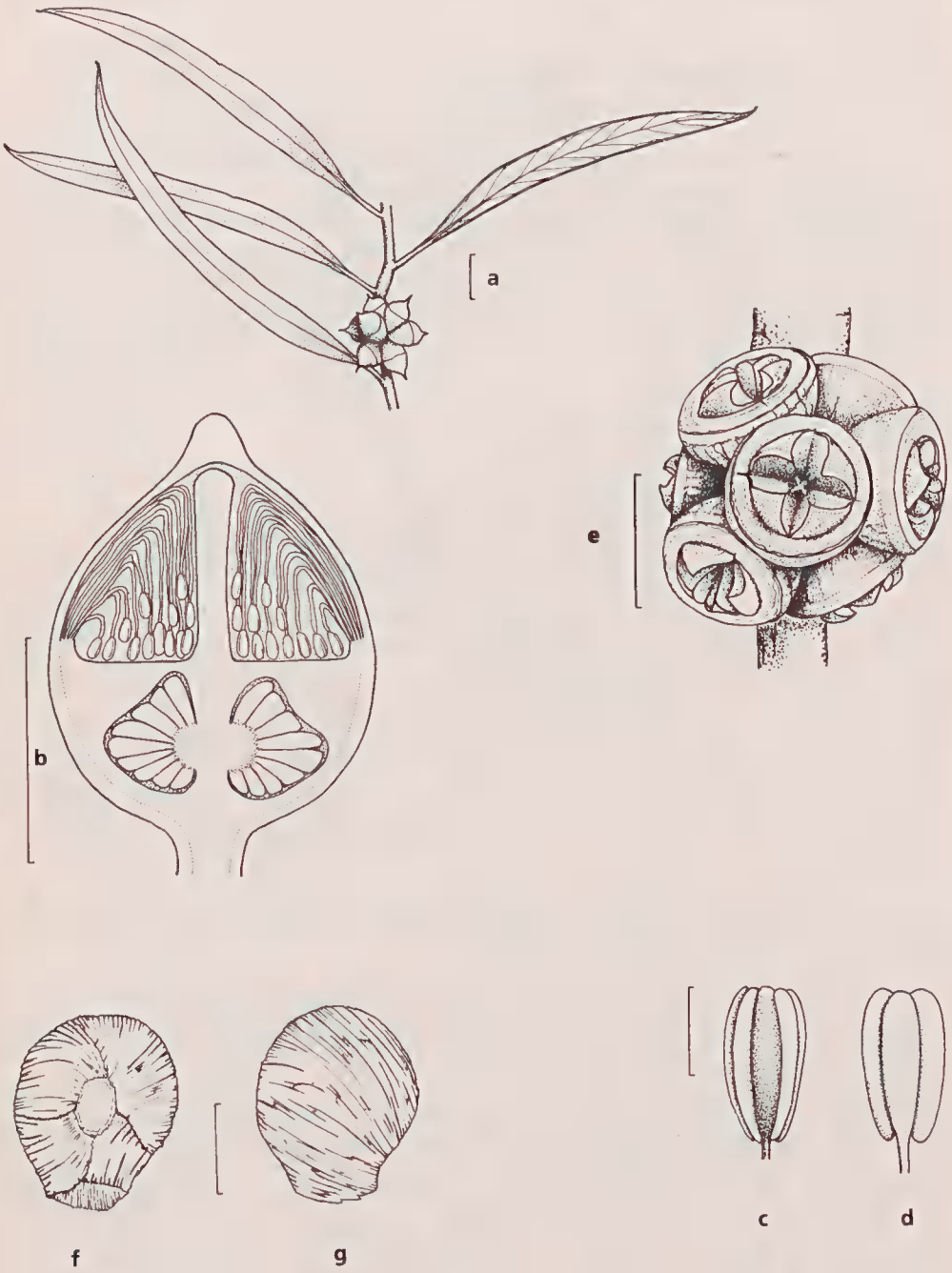

Figure 7. *E. terebra*. **a,** adult leaves and buds. **b,** median section of bud. **c, d,** anther; **e,** fruits. **f, g,** seed (all from *Hill 290 & Johnson*). Scale bar: a, e = 1 cm; b = 5 mm; f, g = 1 mm; c, d = 0.5 mm.

Distinguished by the non-glaucous branchlets; the 3-flowered umbellasters; and the sessile fruits which are much broader than long.

Locally common over a restricted area between Kumarl and south of Salmon Gums, extending west into uninhabited country some distance northeast of Ravensthorpe (Roe District) (Figure 5).

Hybrids are recorded with *E. salubris* and *E. terebra*.

Selected specimens (from 18 examined): Western Australia (N to S): 56.6 km W of Coolgardie-Norseman road on Hyden track, *Hill 612, Johnson & Blaxell*, 7 Nov 1983 (NSW); 10 miles [16 km] W of Esperance-Norseman road to Lake King, *Cranfield 749*, 23 Sep 1978 (NSW); 0.5 miles [0.8 km] N of Kumarl, *Baker 66*, 13 Nov 1970 (NSW); 2 miles [3.2 km] S of Kumarl, *Johnson W187*, 18 Dec 1960 (NSW); 70 km S of Norseman, *Blaxell 1676*, 21 June 1978 (NSW); 1.4 km N of Peak Charles, *Brooker 7501*, 02 May 1982 (NSW); 9.8 miles [15.7 km] NW of Salmon Gums, *Chippendale 392*, 24 Mar 1968 (NSW); 2 miles [3.2 km] N of Salmon Gums, *Brooker 2497*, 15 Feb 1970 (NSW); Salmon Gums, *Gardner 2226*, 24 May 1924 (NSW); 20 km W of Peak Charles Road from Cups Road, *Burgman*, 1983 (NSW); 3.1 km N of southern boundary of Peak Charles National Park, *Brooker 9534*, 08 Nov 1986 (NSW); 80 km NE of Ravensthorpe, *Crisp 6036*, 21 Sep 1979 (NSW); 5 km W of Lort River, *Brooker 7129*, 12 Nov 1981 (NSW).

8. Eucalyptus creta *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: haud glauca; umbellastrae triflorae; omnes partes grossae; fructus distincte latiores quam longiores.

Type: Western Australia: 51.4 km NE of Howick Road on Mt Ney track, *K. Hill 296 & L.A.S. Johnson*, 21 Oct 1983 (holo NSW; iso CANB, PERTH).

Tree to 10 m high. *Bark* smooth, shining, yellow-brown, dark bronze or greenish brown to coppery. *Adult leaves* lanceolate or narrow-lanceolate, disjunct, acuminate, similifacial, distinctly glossy, 6–10 cm long, 1–1.8 cm wide; petioles 0.6–1.2 cm long; lateral veins irregular, widely spaced, at 30–45° to midrib; intramarginal vein distinct, 0.5–1.5 mm from margin; oil glands widely scattered, large, stellate. *Umbellasters* simple, axillary, 3-flowered; peduncles terete, 1–3 mm long. *Mature buds* sessile, globular to ovoid, apiculate; calyptra as long as hypanthium or slightly longer, acuminate. *Fruits* broadly hemispherical to campanulate, 2-winged, 4–5-locular, 9–12 mm long, 15–21 mm diam.; calyptra scar 1.5–2.5 mm wide, vertically raised, almost continuous with hypanthium; disc 1.5–3 mm wide, flat; valves broadly triangular, exserted, incurved. Figure 8.

Distinguished by the non-glaucous branchlets; the 3-flowered umbellasters; and the fruits much broader than long. All parts are generally larger and coarser than in other gimlets.

Locally common in remote country between 122°E and 123° E, and 32° 45'S and 33° 15'S (Roe District) (Figure 5).

Associated with *E. terebra* in the eastern parts of the range (of *E. creta*), but apparently not interbreeding.

From the Latin *cretus*, grown bigger, referring to the buds, flowers and fruit. The epithet has no connection with that of *E. cretata* Lang & Brooker (1990), a member of a different section (*Dumaria*). The epithets are not orthographical variants or homonyms. The epithet '*creta*' was used on herbarium collections and in lists distributed by us well before '*cretata*' was made known.

Selected specimens (from 6 examined): Western Australia (N to S): 15 km W of 'Beard site', *Burgman*, 1983 (NSW); 30 miles [48 km] NE of Mt Ney, *Beard 6371*, 16 Sep 1970 (NSW); 28.0 km N of Mt Ridley turnoff on Dempster road, *Hill 2254, Johnson, Brooker & Blaxell*, 5 Nov 1986 (NSW,

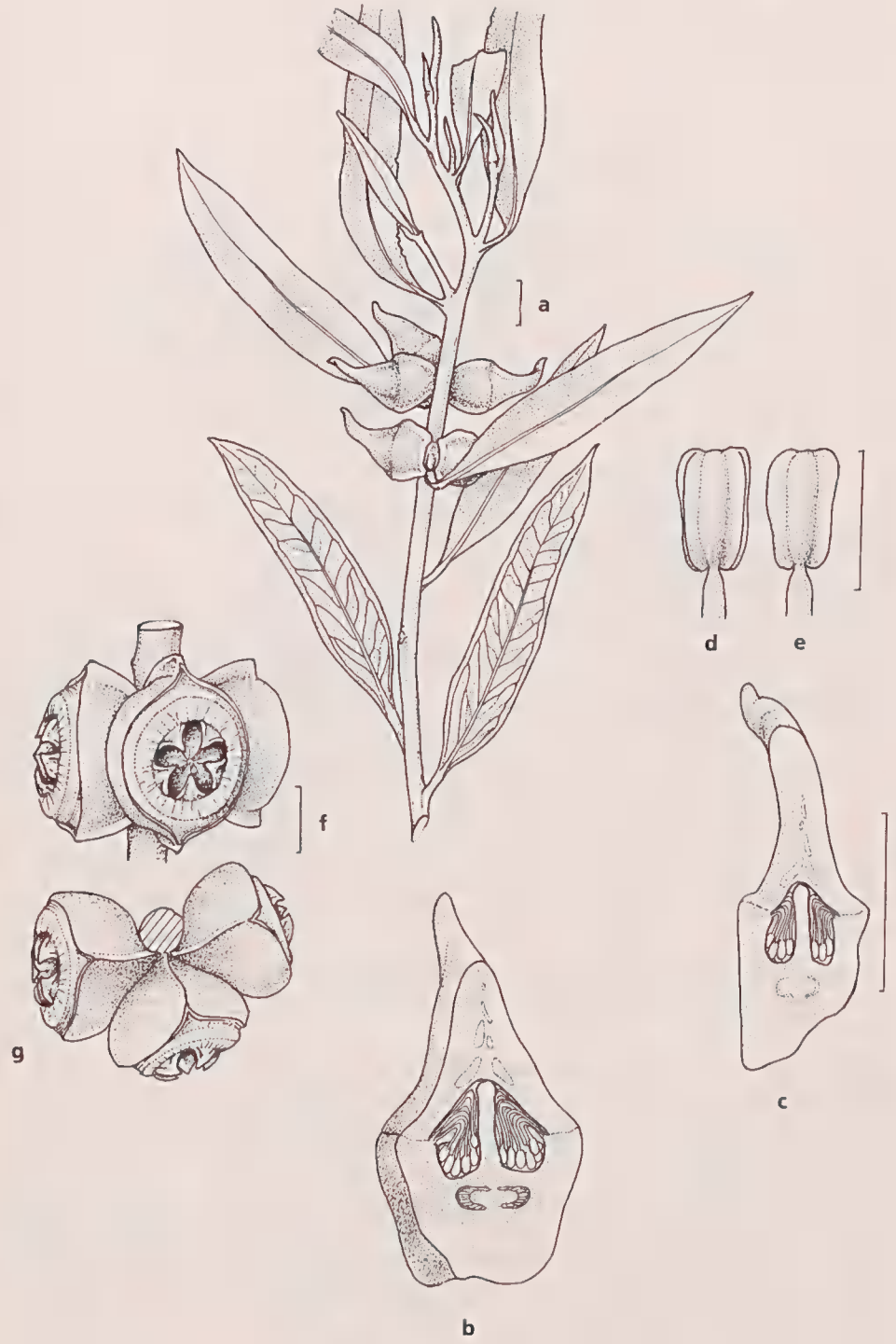

Figure 8. *E. creta*. **a,** adult leaves and buds. **b, c,** median sections of buds. **d, e,** anther **f, g,** fruits (all from *Beard 6371*). Scale bars: a, b, c, f, g = 1 cm; d, e = 5 mm.

CBG, CANB, MEL, PERTH); 27.3 km NE on Dempster Rd from Mt Ridley turnoff, *Brooker 8922*, 9 Apr 1985 (NSW).

Subseries Effusosae

Mallees. Bark rough on trunk.

The subseries *Effusosae* differs from the subseries *Salubrosae* in having some persistent bark, but the smooth areas are comparable to the smooth bark of the other gimlets. The ecological preferences are also different, this group occurring on shallow or skeletal soils on rocky or lateritic slopes.

A subseries of one species.

9. Eucalyptus effusa *Brooker*, Nuytsia 2(2): 108, Figure 5 (1976).

TYPE CITATION: 'Type: 112 km E of Norseman by road towards Balladonia, Western Australia (32°02' S, 122°57' E) 12 Mar. 1967, *G.M. Chippendale 157* (Holo: FRI; Iso: NSW, MEL, PERTH).'

TYPE: the holotype is now held in CANB.

Tree or mallee to 4 m high. *Bark* persistent, ribbony or subfibrous to 2.5 m, smooth, glossy green-brown above. *Seedling leaves* oblanceolate, obtuse, petiolate, opposite. *Juvenile leaves* broad-lanceolate to ovate, acute, petiolate, opposite to 8–10th node; then disjunct, lanceolate. *Adult leaves* disjunct, lanceolate, acute or acuminate, glossy, 5–10 cm long, 0.6–1.5 cm wide; petioles terete, 0.5–1.0 cm long; lateral veins at 30–45° to midrib, moderately to widely spaced, ± irregular, incipiently degenerate; reticulum obscure; intramarginal vein usually obscure or at edge of leaf. *Umbellasters* axillary, 7-flowered; peduncles ± flattened, 3–13 mm long; pedicels terete, 1–3 mm long. *Mature buds* ovoid, 6–7 mm long, 3–4 mm diam.; calyptra conical or hemispherical to oblong, rounded or obtuse, 1–1.5 times longer than hypanthium. *Stamens* all fertile; filaments inflexed in bud; anthers elongate-ovoid, basifixed, versatile; cells ± divergent, dehiscing by long parallel slits. *Fruits* cup-shaped, 3-locular, 4–7 mm long, 5–6 mm diam.; calyptra scar ± continuous with hypanthium, c. 0.5 mm wide; disc flat, c. 1 mm wide; valves broadly triangular, flat or slightly exserted. *Seeds* flattened, discoid, finely and deeply pitted, toothed around the edge, dull orange-brown, c. 1.5 mm diam.; hilum ventral; chaff similar, smaller, angular.

Two widely disjunct subspecies are recognised.

Key to the subspecies

1 Branchlets not glaucous; calyptra conical ..... **9A.** subsp. **effusa**
1* Branchlets distinctly glaucescent; calyptra rounded ..... **9B.** subsp. **exsul**

9A. Eucalyptus effusa *Brooker* subsp. **effusa**

Bark persistent to 2.5 m. Branchlets not glaucous. Adult leaves 5–10 cm long, 0.7–1.5 cm wide; petioles 7–10 mm long. Peduncles 3–10 mm long, pedicels 1–3 mm long. Calyptra conical.

Locally frequent on shallow soils over greenstones (amphibolites) on the Fraser Range between Norseman and Balladonia (Coolgardie district) (Figure 9).

SELECTED SPECIMENS (from 14 examined): WESTERN AUSTRALIA (W to E): 115 km E of Norseman, *Pullen 9595*, 23 Nov 1974 (NSW); 70 miles [112 km] E of Norseman, *Chippendale 157*, 12 Mar 1967 (NSW); 66 km W of Balladonia, *Strid 21927*, 04 Jan 1983 (NSW); 150 km E of Norseman, *Brooker 6425*, 21 Aug 1979 (NSW); Southern Hill Station, Fraser Range, *Beard 6300*, 12 Sep 1970 (NSW);

32 km W of Balladonia, *Brooker 7486*, 28 Apr 1982 (NSW); 30 km W of Balladonia, *Hill 224 & Johnson*, 19 Oct 1983 (NSW).

9B. Eucalyptus effusa *Brooker* subsp. **exsul** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica ramulis glaucescentibus calyptra rotundata et pedunculis 7 mm excedentibus differt.

TYPE: WESTERN AUSTRALIA: 141.9 km NE of Paynes Find towards Sandstone (28° 37'S, 118° 47'E), *L.D. Pryor 133 & J.D. Briggs*, 21 Oct 1978 (holo NSW; iso CANB).

Bark persistent to 1.5 m. Branchlets glaucescent. Adult leaves 5–9 cm long, 0.5–1.2 cm wide; petioles 5–11 mm long. Peduncles 8–13 mm long, pedicels 2–3 mm long. Calyptra hemispherical to oblong.

Known only from a small area near Youanmi (Austin District), where the apparently small populations occur on shallow red loam over lateritic soil residuals (Figure 9).

The epithet is from the Latin *exsul*, an exile, from its occurrence in far isolation from the other subspecies.

SELECTED SPECIMENS (from 7 examined): WESTERN AUSTRALIA (N to S): 75 km SW of Sandstone, *Brooker 9258*, 18 Apr 1986 (NSW); 83.1 km from Sandstone towards Paynes Find, *Brooker 8711*, 17 Oct 1984 (NSW, CANB); 3.7 km SW of Youanmi crossroad on Paynes Find road, *Hill 2595 & Johnson*, 24 Nov 1986 (NSW, PERTH).

Series Annulatae

Pith glands present. Stomata small, green. Cuticle glossy. Oil glands in adult leaves spherical, densely packed. Filaments erect. Anthers elongate, dorsifixed, versatile. Disc very narrow. Stemonophore broad, raised and overlying ovary. Valves raised, acuminate. Seeds irregular, ragged and deeply pitted; hilum ventral.

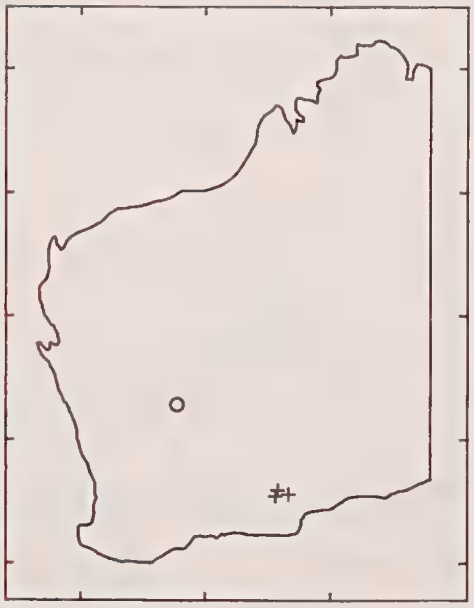

Figure 9. Distribution of *E. effusa* subsp. *effusa* (+) and *E. effusa* subsp. *exsul* (○).

Members of series *Annulatae* differ from those of series *Salubres* in having erect filaments in bud, a strongly produced stemonophore overlying most of the ovary top, a very narrow or almost obsolete disc, and raised, acuminate valves in the fruits.

The three species recognised in this subseries exhibit a geographic replacement pattern (Figure 10).

10. Eucalyptus annulata *Benth.*, Fl. Austral. 3: 234 (1867).

TYPE CITATION: 'W. Australia, Salt River, Maxwell.'

TYPE: holo K; iso MEL.

Tree to 8 m high, branches erect and arising near base. *Bark* smooth throughout, glossy or semiglossy dark green-brown or bronze to yellow-brown. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, glossy green, 6–10 cm long, 1.0–1.5 cm wide; petioles 10–20 mm long; lateral veins moderately spaced, regular, at 30°–40° to midrib; intramarginal vein continuous, ± distinct, to 1 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, flattened, 5–10 mm long, to 9 mm wide apically. *Mature buds* sessile, cylindrical, basally angular, 13–18 mm long, 4–6 mm diam.; calyptra cylindrical to elongate conical, acute, 3–4 times as long as hypanthium. *Fruits* obconical to cup-shaped, often basally angular, 3–4-locular, 6–7 mm long, 8–11 mm diam.; disc slightly raised or flat, ± incurved ultimately, 0.5–1.5 mm wide; valves broadly triangular, obtuse or acute, basally ± enclosed, apically vertically exserted.

Distinguished by the flat peduncle; the sessile buds and fruits; and the calyptra rounded at the tip.

Locally frequent in almost pure stands on heavier soils, from between Dumbleyung and north of the Stirling Range in the west, east to north of Mt Ney (Roe and Eyre Districts) (Figure 10).

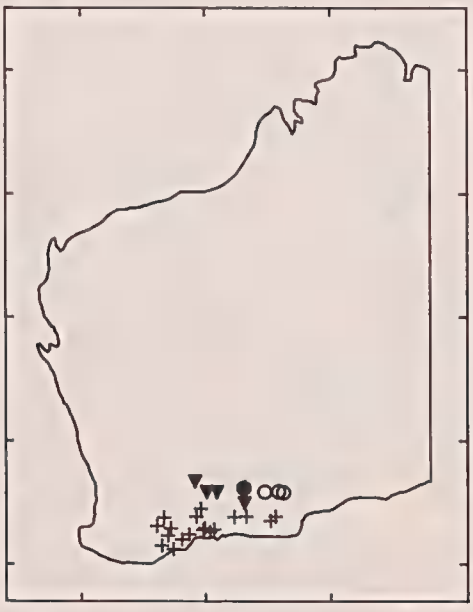

Figure 10. Distribution of *E. annulata* (+), *E. extensa* (▼), *E. protensa* (○) and *E. extensa* – *E. protensa* intergrade (●).

Selected specimens (from 29 examined): Western Australia (W to E): Gnowangerup, *Grasby*, 12 Nov 1916 (NSW); 6 miles [9.6 km] from Lake Grace towards Kukerin, *Wrigley*, 9 Nov 1968 (NSW); 7.5 miles [12.1 km] NNW of Ongerup, *Tindale 3896 & Newbey*, 31 Aug 1973 (NSW); 2.8 km from Pingrup-Newdegate road on Range Road, *Brooker 9125*, 27 Nov 1985 (NSW); Cheyne Bay, *Brooker 8740*, 29 Nov 1984 (NSW); W of Pallinup River, *Brooker 8871*, 2 Mar 1985 (NSW); 5.7 km S of Monkey Rock Road on Carlawillup Road, *Hill 3119*, 6 Sep 1988 (NSW); 17 km SE of Jerramungup, *Foreman 1349*, 30 Nov 1985 (NSW); corner Devils Creek Road & Carlawillup South Road, *Brooker 9908*, 9 Mar 1988 (NSW, CANB); 1 mile [1.6 km] to Newdegate from Lake King, *Wrigley*, 6 Nov 1968 (NSW); 7.4 km E of rabbit-proof fence on Varley - Southern Cross road, *Hill 3050*, 1 Sep 1988 (NSW, CANB, PERTH); 8 miles [12.8 km] NW of Ravensthorpe, *Chippendale 219*, 17 Mar 1967 (NSW); 16 km S of Ravensthorpe, *Crisp 5000*, 10 Jan 1979 (NSW); 16 km N of Rollands Road on Fields Road, *Hill 2314, Johnson & Blaxell*, 7 Nov 1986 (NSW, CBG, CANB, MEL, PERTH); Dowak, N of Salmon Gums, *Johnson W190*, 18 Dec 1960 (NSW); 15.8 km NE of Logans Road on Mt Ney Road, *Hill 2256 & Johnson*, 5 Nov 1986 (NSW, CBG, CANB, MEL, PERTH); 24.7 km NE of Howick Road, along survey track, *Hill 295 & Johnson*, 21 Oct 1983 (NSW);

11. Eucalyptus extensa *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: pedunculi applanati; alabastra fructusque pedicellati; calyptra apice rotundata.

Type: Western Australia: 14.7 km N of Hyden-Norseman track along Mt Day track, turnoff 123.0 km W of Norseman–Coolgardie road (32° 07′S, 120° 29′E), *K. Hill 626, L. Johnson, D. Blaxell, I. Brooker, S. Hopper*, 7 Nov 1983 (holo NSW; iso CANB, K, PERTH).

Tree or mallee to 8 m high. *Bark* smooth throughout, semiglossy, grey, grey-green, brown or yellow. *Adult leaves* disjunct, similifacial, narrow- to broad-lanceolate,

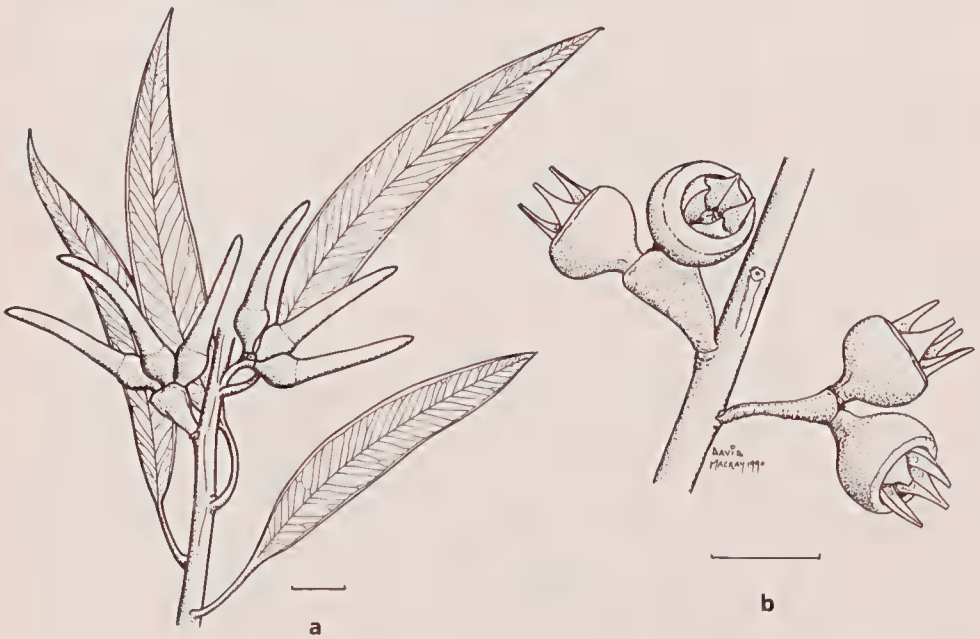

Figure 11. *E. extensa*. **a,** adult leaves and buds. **b,** fruits (all from *Blaxell 1677*). Scale bars = 1 cm.

obtuse, apiculate, 5–9 cm long, 0.7–1.7 cm wide; petioles to 1.3 cm long; lateral veins moderately spaced, regular, at 30°–45° to midrib; reticulum obscure; oil glands large, densely packed; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles flattened, 8–12 mm long, 4–8 mm wide apically; pedicels terete or angular, 1–3 mm long. *Mature buds* elongate-cylindrical, 17–25 mm long, 5–7 mm diam.; calyptra cylindrical, obtuse, 4–6 times longer than hypanthium. *Fruits* cup-shaped to globular-truncate, 3–4-locular, 6–8 mm long, 7–10 mm diam.; calyptra scar raised at c. 45°, 0.5–1.0 mm wide; stemonophore slightly raised, ultimately incurved, 0.5–1.5 mm wide; valves narrowly triangular, elongate, acute, basally enclosed, apically strongly vertically exserted and ultimately out-turned. Figure 11.

Distinguished by the flat peduncles; the pedicellate buds and fruits; and the calyptra rounded at the tip.

Locally frequent from Mt Day to south of Norseman (Coolgardie District) (Figure 10).

Limited intergrades are recorded with *E. protensa*.

The epithet is from the Latin *extensus*, extended, referring to the long calyptra and the developed pedicels.

Selected specimens (from 7 examined): Western Australia (N to S): 91.6 km N of Coolgardie–Hyden road on Varley – Southern Cross road, *Hill 2905*, 26 Aug 1988 (NSW, CANB, PERTH); 23 miles [37 km] SW of Norseman, *Chippendale 169*, 13 Mar 1967 (NSW); 27 miles [43 km] SW of Norseman, *Chippendale 387*, 24 Mar 1967 (NSW); c. 70 km S of Norseman, *Blaxell 1677*, 21 June 1978 (NSW).

12. Eucalyptus protensa *L. Johnson & K. Hill*, **sp. nov.**

Inter species subsectionis distinguitur: pedunculi teretes; alabastra fructusque pedicellati; calyptra apice acuta; fructus majusculi, globulares.

Type: Western Australia: 60 km E of Norseman along Eyre Highway (32°04'S, 122°22'E), *K. Hill 690 & D. Blaxell*, 14 Nov 1983 (holo NSW; iso CANB, K, PERTH).

Tree branched at or near base, or mallee, to 10 m high. *Bark* smooth, semiglossy, grey-green or olive to yellow-brown, shedding in ribbons. *Adult leaves* glossy, lanceolate, to 15 cm long, 1.5 cm wide, petioles 1.0-1.8 cm long; lateral veins widely spaced, at 15° - 30° to midrib; reticulum degenerate; oil glands large, densely packed; intramarginal vein distinct, continuous, 0.5-1.0 mm from margin. *Umbellasters* axillary, 7-flowered; peduncles ± terete, vaguely 2-angled, to 15 mm long; pedicels terete or faintly angled, to 7 mm long. *Mature buds* elongate-cylindrical, apically tapered, 30-45 mm long, 7-9 mm diam.; calyptra cylindrical, tapered, acute, much narrower than hypanthium, c. 6-8 times longer than hypanthium. *Fruit* globular or hemispherical, 3- or 4-locular, 7-10 mm long, 8-13 mm diam.; disc and calyptra scar flat, c. 0.5 mm wide; stemonophore flat to slightly raised, ultimately incurved, 1.0-1.5 mm wide; valves narrowly triangular, basally enclosed, apically strongly vertically exserted, long acuminate, bases enclosed. *Seeds* dull, brown, fringed, flattened. Figure 12.

Distinguished by the terete peduncles; the pedicellate buds and fruits; the very long acute calyptra; and the large, globular fruits.

Locally frequent in the country to the east and west of the Fraser Range, between Norseman and Balladonia (Coolgardie District). Usually on calcareous soils on greenston (Figure 10).

Intergrades are recorded with *E. extensa* in the limited area of contact.

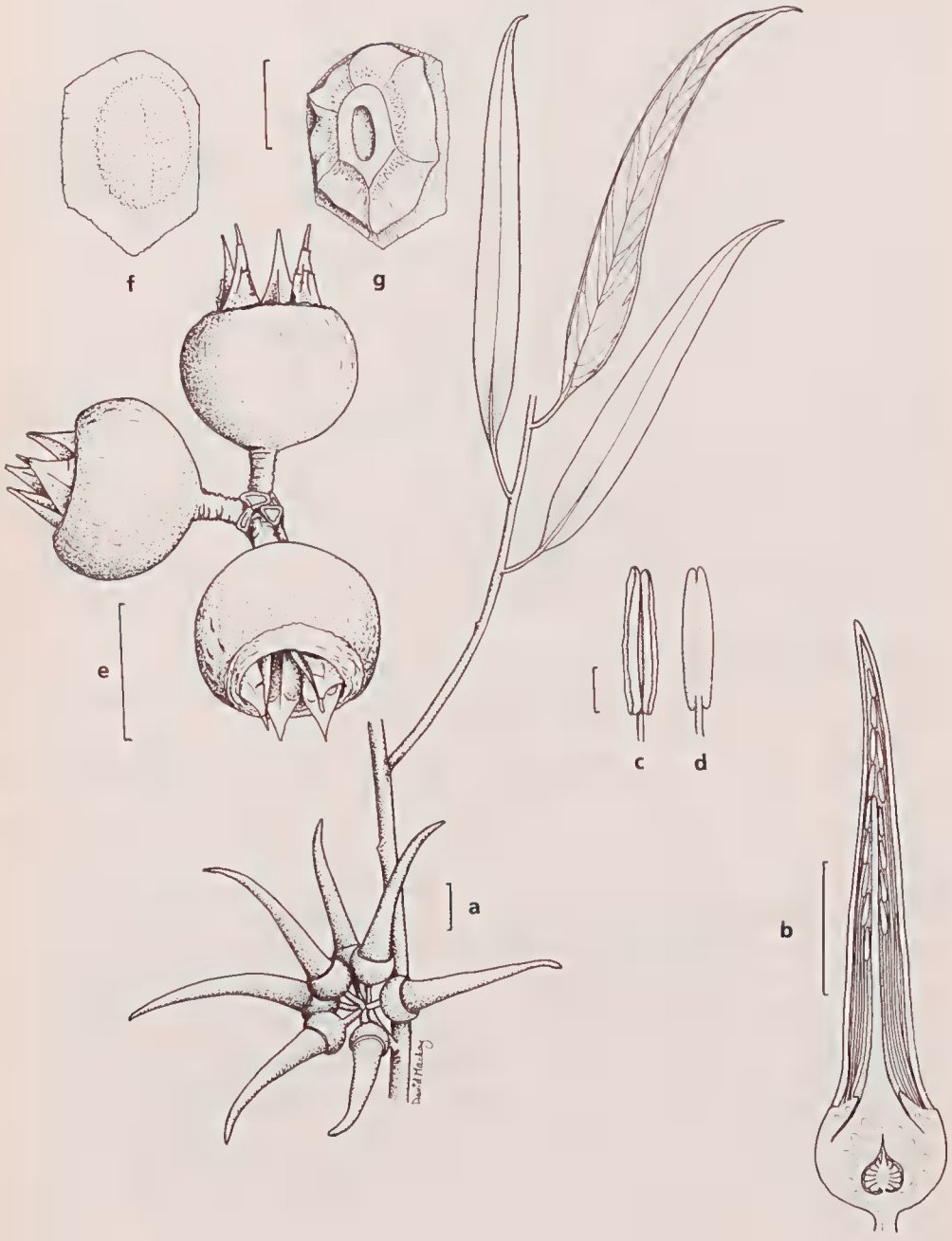

Figure 12. *E. protensa*. **a,** adult leaves with buds. **b,** median section of bud. **c, d,** anther. **e,** fruits. **f, g,** seed (all from *Hill 690 & Johnson*). Scale bar: a, b, e = 1 cm; c, d, f, g = 1 mm.

The epithet is from the Latin *protensus*, elongated, referring to the very long calyptra.

SELECTED SPECIMENS (from 8 examined): WESTERN AUSTRALIA (W to E): 125 km E of Norseman, *Brooker 6453*, 22 Aug 1979 (NSW); 74 km W of Balladonia roadhouse, *Hill 233 & Johnson*, 19 Oct 1983 (NSW); 71 km from Balladonia motel, *Crisp 5645*, 02 Feb 1979 (NSW); 55.3 km W of Balladonia roadhouse on hwy, *Hill 2823*, 24 Aug 1988 (NSW); 54.5 km W of Balladonia roadhouse on highway, *Hill 2206 & Johnson*, 4 Nov 1986 (NSW, CBG, CANB, MEL, PERTH).

Intergrading populations and hybrids

Specimens cited as from intergrading populations are from sizeable populations with intermediate characters between those of the parent species. Distributions of these populations are given in Figure 13. Those cited as hybrids are from single occurrences of an individual in an area where the two parent species grow together and where there is no apparent evidence of interbreeding beyond the F_1 generation.

E. ravida – E. salubris (9 specimens examined): 37 km W of Coolgardie, *Brooker 6470*, 23 Aug 1979 (NSW, CANB); Bullabulling, *Stoward 89*, Mar 1971 (NSW); 8 miles [12.5 km] E of Merredin, *Johnson W124A*, 16 Dec 1960 (NSW); 6.3 miles [10 km] E of Ghooli, *Chippendale 268*, 11 Aug 1967 (NSW, CANB).

E. salubris – E. tortilis (3 specimens examined): 17 km E of grid in rabbit-proof fence E of Hyden, *Brooker 8622*, 9 Aug 1984 (NSW); 93.7 km W of Balladonia roadhouse on hwy, *Hill 2826*, 24 Aug 1988 (NSW); 51 km N of Ravensthorpe, *Hill 316, 317, Johnson & Blaxell*, 22 Oct 1983 (NSW).

E. diptera – E. salubris (5 specimens examined): 24.6 miles [39.4 km] S of Norseman, *Brooker 2492*, 15 Feb 1970 (NSW); 3.8 km N of Hayes Road on North Road, *Hill 3029*, 1 Sep 1988 (NSW); 16.1 km from Highway on Peak Charles road, *Hill 2322, Johnson & Blaxell*, 8 Nov 1986 (NSW, PERTH).

E. diptera – E. terebra (1 specimen examined): 52.8 km W of Coolgardie–Norseman road on Hyden track, *Hill 2855*, 25 Aug 1988 (NSW).

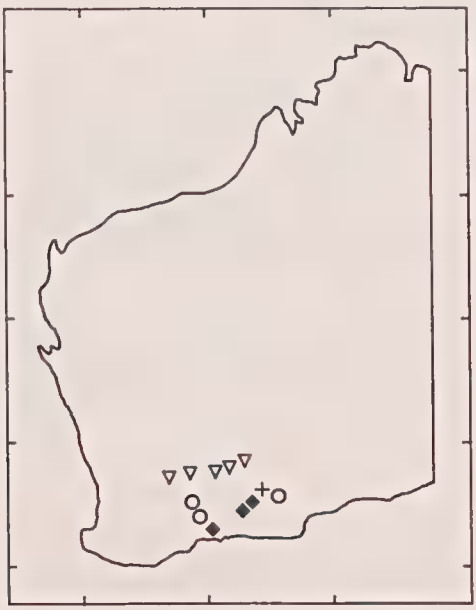

Figure 13. Distributions of the intergrades *E. ravida* –*E. salubris* (▽), *E. salubris* – *E. tortilis* (○), *E. diptera* –*E. salubris* (◆) and *E. diptera* – *E. terebra* (+).

E. ravida x E. tortilis (1 specimen examined): 47.5 km E of Norseman, *Hill 2221 & Johnson*, 4 Nov 1986 (NSW, CANB, CBG, MEL, PERTH).

E. extensa – E. protensa (1 specimen examined): 30 km NW of Norseman, *Crisp 5940, Taylor & Jackson*, 19 Sep 1979 (NSW).

E. annulata x E. creta (1 specimen examined): 42.8 km NE of Logans road on Mt Ney road, *Hill 2259 & Johnson*, 5 Nov 1986 (NSW).

This is the only interserial hybrid known for any of the species treated.

Acknowledgements

Our colleague in the overall project, Don Blaxell, has contributed helpful discussions on many points and has been involved the recognition of several of the taxa. Thanks are due to Leonie Stanberg, who has provided essential assistance through the project and drafted the distribution maps, and David Mackay, who prepared most of the illustrations (Bob Roden prepared the illustration of *E. creta*). Ian Brooker most helpfully drew attention to certain of the distinctive characters of the series and made suggestions for changes, which we have largely taken up.

References

Beard, J.S. (1980) A new phytogeographic map of Western Australia. *Western Australian Herb. Research Notes* 3: 37–58.

Bentham, G. (1867) *Flora australiensis*, vol. 3 (L. Reeve: London).

Blakely, W.F. (1934) *A key to the eucalypts* (The Worker Trustees: Sydney).

Brooker, M.I.H. & Kleinig, D.A. (1990) *A field guide to* Eucalyptus, vol. 2 (Inkata: Melbourne).

Burgman, M.A. (1985) Cladistics, phenetics and biogeography of populations of *Boronia inornata* Turcz. (Rutaceae) and the *Eucalyptus diptera* Andrews (Myrtaceae) species complex in Western Australia. *Austral. J. Bot.* 33(4): 419–431.

Chippendale, G.M. (1988) *Eucalyptus*. In A.S. George (ed.), *Flora of Australia*, vol. 19 (AGPS: Canberra).

Hill, K.D. (1989) Mallee eucalypt communities: their classification and biogeography. Pp. 93–108, in J.C. Noble & R.A. Bradstock (eds.), *Mediterranean landscapes in Australia: Mallee ecosystems and their management* (CSIRO: Melbourne).

Lang, P.J. & Brooker, M.I.H. (1990) Two new mallee species from South Australia in *Eucalyptus* L'Hérit. series *Rufispermae* Maiden. *J. Adelaide Bot. Gard.* 13: 65–78 (1990).

Maiden, J.H. (1903–1933) *A critical revision of the genus* Eucalyptus (Govt. Printer: Sydney).

Pryor, L.D. & Johnson, L.A.S. (1971) *A classification of the eucalypts* (ANU Press: Canberra).

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Systematic studies in the eucalypts – 3
New taxa and combinations in *Eucalyptus* (Myrtaceae)

K.D. Hill and L.A.S. Johnson

Abstract

Hill, K.D., and Johnson, L.A.S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. Systematic studies in the eucalypts – 3. New taxa and combinations in Eucalyptus *(Myrtaceae).* Telopea *4(2): 223–267.* A number of new taxa are described at specific and subspecific rank, and other changes to names and status are made. New species are *E. disclusa* L. Johnson & Blaxell, *E. vicina* L. Johnson & K. Hill, *E. lockyeri* Blaxell & K. Hill, *E. alligatrix* L. Johnson & K. Hill, *E. conspicua* L. Johnson & K. Hill, *E. paedoglauca* L. Johnson & Blaxell, *E. prominula* L. Johnson & K. Hill, *E. tenella* L. Johnson & K. Hill, *E. ralla* L. Johnson & K. Hill, *E. imitans* L. Johnson & K. Hill, *E. spectatrix* L. Johnson & Blaxell, *E. laophila* L. Johnson & Blaxell, *E. obstans* L. Johnson & K. Hill (formerly known as *E. obtusiflora auct. non.* DC.), *E. langleyi* L. Johnson & Blaxell, *E. copulans* L. Johnson & K. Hill, *E. serpentinicola* L. Johnson & Blaxell and *E. lacrimans* L. Johnson & K. Hill. The new name *E. parvula* L. Johnson & K. Hill is provided for *E. parvifolia* Cambage, non Newberry. New subspecies are described in *Eucalyptus parramattensis* C. Hall (subsp. *decadens* L. Johnson & Blaxell), *E. rubida* Deane & Maiden (subspp. *canobolensis* L. Johnson & K. Hill, *septemflora* L. Johnson & K. Hill, and *barbigerorum* L. Johnson & K. Hill) and *E. caleyi* (subsp. *ovendenii*). *E. tricarpa* (L. Johnson) L. Johnson & K. Hill is elevated to specific rank (formerly a subspecies of *E. sideroxylon* Cunn. ex Woolls). *E. pulverulenta* Sims var. *lanceolata* Howitt is lectotypified in order to place it unequivocally into the synonymy of *E. cephalocarpa* Blakely.

Introduction

New taxa described here are a small selection of a large number that have been defined during an overall revision of the eucalypts now in progress. These are mainly taxa occurring in New South Wales, which we need to publish in order to validate names for use in the forthcoming second volume of the *Flora of New South Wales*. A number of other new species from New South Wales have already been described by Johnson & Hill (1990). At this stage, *Eucalyptus* L'Hérit. will be used in the traditional sense. The species are not allocated alphabetic codes according to the system of Pryor & Johnson (1971), since these are being revised. Species are treated in the order in which they occur in the revised classification being developed from that of Pryor & Johnson.

Rare or threatened species are allocated conservation status codes according to the system of Briggs & Leigh (1988).

Terminology

The term 'stemonophore' is used throughout as a more acceptable combination of Greek elements than the Latin-Greek hybrid 'staminophore' (after Johnson & Briggs 1984).

The term 'calyptra' is used throughout in place of 'operculum' as traditionally used in *Eucalyptus*. The latter term has been used in *Eucalyptus* alone, whereas the former

is the accepted term for fused perianth structures occurring widely in Myrtaceae (Johnson & Briggs 1984, following McVaugh 1968). The calyptra in all *Monocalyptus* taxa is described as 'appearing single' in reference to the actually complex nature and origin of this structure, to be discussed elsewhere.

The hairs on juvenile leaves of stringybark taxa are described as 'stellate hairs' for brevity. These are not stellate hairs as occurring in for example certain Chenopodiaceae, but distinctive structures in which a number of simple hairs arise from a raised oil gland (discussed by Johnson (1972) and Ladiges (1984)).

Bark is described as 'persistent' in cases where it is not regularly shed, and 'smooth' when regularly shedding. The former includes 'stringybark', 'box' and 'ironbark' among other types, and the latter covers the 'gum' barks.

Species authorship is to be cited as presented under each taxon described. They are not cases for the use of 'ex'.

1. Eucalyptus parramattensis *C. Hall*, Proc. Linn. Soc. New South Wales 37: 568, pl. 60, 61 (1913).

TYPE CITATION: 'Hab – Fairfield, Cabramatta, Auburn (C. Hall), Milton (R. T. Baker), all in New South Wales.'

TYPE: NEW SOUTH WALES: Central Coast: near Public School, Fairfield, *C. Hall* (lecto NSW).

Typification established by Maiden (Crit. Revis. Eucalyptus 4: 38 (1917)).

[*E. tereticornis* Sm. var. *amblycorys* F. Muell. ex Maiden, Crit. Revis. Eucalyptus 4: 15 (1917), in part, pro. syn., nom. invalid. Discussed under *E. prava* L. Johnson & K. Hill (Johnson & Hill 1990).]

Tree to 15 m tall. *Bark* regularly shedding but showing a rough and granular texture, patchy grey, brownish grey, orange and pinkish white, often shedding irregularly. *Adult leaves* disjunct, stiff, usually falcate, lanceolate, 7–20 cm long, 1.0–3.5 cm wide; lateral veins irregular, reticulate, at 30° to 50° to midrib, intramarginal vein distinct, to 2.5 mm from margin; petiole 10–25 mm long, grooved above. *Umbellasters* axillary, 7- flowered; peduncles 2- or 3-angled, 5–10 mm long; pedicels angled, 2–8 mm long. *Mature buds* 6–10 mm long, 3–6 mm wide; calyptra 1½ to 2½ times longer than hypanthium, rounded, obtuse, often wider than hypanthium at widest point; outer calyptra scar distinct, outer calyptra sometimes present on near mature buds. *Fruits* campanulate or hemispherical, 5–7 mm long, 5–9 mm diam., 3- or 4-locular with prominently exserted broadly triangular sometimes tapered valves; calyptra scars forming a distinct ridged band 1–2 mm wide around hypanthium; disc narrow, distinct from hypanthium, raised and incurved to enclose bases of valves. *Seeds* brown, glossy, angular, to 1 mm long; chaff similar, longer and thinner.

Two allopatric subspecies may be recognised within *E. parramattensis*.

Key to the subspecies

1 Fruits < 7 mm diameter ..... **1A.** subsp. **parramattensis**
1* Fruits > 7 mm diameter ..... **1B.** subsp. **decadens**

1A. Eucalyptus parramattensis *C. Hall* subsp. **parramattensis**

= *E. parramattensis* C. Hall var. *sphaerocalyx* Blakely, Key Eucalypts: 133 (1934). TYPE CITATION: 'N.S.W. - Duck River, Parramatta (Dr. Woolls); Richmond, Bankstown and

Cabramatta.' TYPE: NEW SOUTH WALES: Central Coast: Duck River, Parramatta, *Woolls* (holo NSW). Although Blakely cited other localities, this was the single specimen fully cited, and was also the single specimen labelled 'Type' by Blakely. Included in *E. parramattensis* by Pryor & Johnson (1971).

[*E. tereticornis* Sm. var. *sphaerocalyx* F. Muell. ex Maiden, Crit. Revis. Eucalyptus 4: 316 (1917), pro. syn., nom. invalid. This name was applied to specimens collected at 'Duck Creek' [Duck River], Parramatta, by Woolls, i.e. the type material of *E. parramattensis* var. *sphaerocalyx* Blakely (see above).]

Tree to 15 m tall. Adult leaves 7–15 cm long, 1–2 cm wide; intramarginal vein to 1 mm from margin; petiole 10–20 mm long. Peduncles 5–10 mm long; pedicels 2–8 mm long. Mature buds 5–8 mm long, 4–5 mm wide. Fruit 3–5 mm long, 5–7 mm diam.

DISTRIBUTION: from east of Mudgee to near Hilltop, with extensive stands in the region between the Hunter and Culoul Ranges (Figure 1).

ECOLOGY: this taxon characteristically occurs on infertile sandy soils, often on sites of impeded drainage.

Hybrids are recorded with *E. longifolia* Link, *E. resinifera* Smith subsp. *resinifera* and *E. punctata* DC.

CONSERVATION STATUS: not considered to be at risk.

SELECTED SPECIMENS (from 77 examined): NEW SOUTH WALES: Central Coast: Howes Valley, *Cambage 1526*, 8 Jul 1906 (NSW); 10.2 km N of Mellong Ck on Putty road, *Brooker 5934*, 28 Apr 1978 (CANB, NSW); SW corner of Castlereagh State Forest, *Coveny 11884 & Goodwin*, 13 Sep 1984 (NSW, BRI, CANB, CBG, K, MEL, PERTH); 1.5 km S of Agnes Banks, *Crisp 7484, Taylor & Weston*, 29 Oct 1984 (CBG, AD, NSW); Cabramatta, *Boorman*, Jul 1917 (NSW); Douglas Park, *Johnson NSW 84442*, 21 Nov 1965; Shepherds Swamp, Hilltop, *Maiden & Boorman*, Sep 1902 (NSW). Central Western Slopes: Munghorn, *Ingram*, 15 Apr 1952 (NSW); 5 miles [8 km] N of Ulan on Cassilis road, *Johnston 59 & Vos*, 5 Nov 1968 (CANB, NSW); c. 3–4 miles [5–6 km] SE of Kindalwry Mtn, S of Rylstone, *Johnson 4515*, 3 Oct 1965 (NSW).

1B. Eucalyptus parramattensis *C. Hall* subsp. **decadens** *L. Johnson & Blaxell*, **subsp. nov.**

Ab subspecie typica alabastris fructibus foliisque omnibus majoribus.

TYPE: NEW SOUTH WALES: North Coast: 1 mile [1.6 km] W of Saltash on Raymond Terrace road, *L.A.S. Johnson*, 15 Apr 1964 (holo NSW 228221).

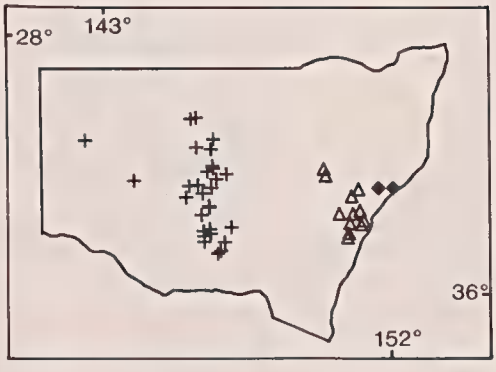

Figure 1. Distribution of *E. parramattensis* C. Hall subsp. *parramattensis* (△), *E. parramattensis* subsp. *decadens* (◆) and *E. vicina* (+).

Tree to 10 m tall, usually less than 7 m. Adult leaves 10–20 cm long, 1.5–3.5 cm wide; intramarginal vein to 2.5 mm from margin; petiole 15–25 mm long. Peduncles 7–10 mm long; pedicels 3–7 mm long. Mature buds 7–10 mm long, 4–6 mm wide. Fruit 5–7 mm long, 7–9 mm diam. Figure 2.

Subspecies *decadens* is distinguished from *E. parramattensis* subsp. *parramattensis* by its larger buds, fruits and leaves.

Distribution: New South Wales: Lower Hunter Valley, Williamtown and Kurri Kurri districts (Figure 1).

Ecology: *E. parramattensis* subsp. *decadens* is restricted to low-lying, often swampy areas on poor sandy soils. It is associated with *E. signata* F. Muell., *E. globoidea* Blakely and *Angophora bakeri* C. Hall.

The epithet is from the Latin *decadens*, falling down, referring to the general 'tumble-down gum' habit of the trees. Since it was drawn to attention by the late Rod W. Earp, it has been familiarly known to L. Johnson and associates as 'Earp's Dirty Gum', alluding to the 'dirty grey' bark.

Conservation status: 2V. Under significant threat from residential development.

Selected specimens (from 14 examined): New South Wales: North Coast: Williamtown, *Earp*, 29 Dec 1955 (NSW), *Johnson*, 27 Jan 1962 (NSW); Tomago, *Bartrim*, Sep 1979 (NSW); 1 km NE of Kurri Kurri, *B.G. Briggs 3280 & Johnson*, 15 Mar 1970 (NSW).

2. Eucalyptus disclusa *L. Johnson & Blaxell*, **sp. nov.**

Ab *E. seeana* distinguitur: folia adulta juveniliaque latiora, fructus major disco plus elevato, calyptra longior angustiorque.

Type: Queensland: Rainbow Falls, Blackdown Tableland, *M.I.H. Brooker 3776*, 31 Aug 1972 (holo NSW; iso CANB).

Tree to 12 m tall, usually less than 8 m. *Bark* smooth, dark grey or brownish grey, with paler patches. *Seedling leaves* petiolate, ovate, rounded, opposite for about 7 nodes. *Juvenile leaves* petiolate, ovate, acute or acuminate, disjunct, to 12 cm long, 6.5 cm wide. *Adult leaves* lanceolate, slighty falcate, 8–18 cm long, 15–30 mm wide; petiole 20–30 mm long; lateral veins irregular, reticulate, at 30°–45° to midrib; intra-marginal vein distinct, 1–3 mm from margin, with reticulate secondary veins between margin and intramarginal vein. *Umbellasters* axillary, usually 7–flowered, occasionally 11-flowered; peduncles terete or 2-angled, 10–20 mm long; pedicels 5–8 mm long. *Mature buds* 12–15 mm long, 3–5 mm diam.; calyptra 3½–6 times longer than hypanthium, evenly conical and acute; outer calyptra shed when buds small, scar prominent. *Stamens* all fertile; filaments upright, not inflexed in bud; anthers ovoid, dorsifixed, versatile, dehiscing by slits. *Fruits* globular, 5–7 mm long, 5–7 mm diam., 3–4-locular; calyptra scar and stemonophore visible on most fruits as narrow bands around top of hypanthium; disc narrow, raised, ultimately incurved or horizontal, sometimes enclosing valve bases; valves broadly triangular, vertically exserted. *Seeds* dark brown, dull, angular, 0.5–0.8 mm long; chaff similar, longer, thinner. Figure 3.

E. disclusa is nearest to *E. seeana* Maiden, from which it is distinguished by the ovate juvenile leaves (lanceolate in the latter), lanceolate adult leaves (narrow-lanceolate in the latter), larger fruits (to 5 mm long in the latter) with more raised disc, and longer, narrower calyptra (usually less than 3 times longer than hypanthium in the latter).

Distribution: Queensland: Blackdown Tableland, Leichhardt District, west of Rockhampton (Figure 4).

Figure 2. *E. parramattensis* subsp. *decadens*. **a**, adult leaves and buds. **b**, median section of bud. **c**, **d**, anther. **e**, fruit (all from *Johnson*, 27 Jan 1962). Scale bar: a, e = 1 cm; b = 5 mm; c, d = 0.1 mm.

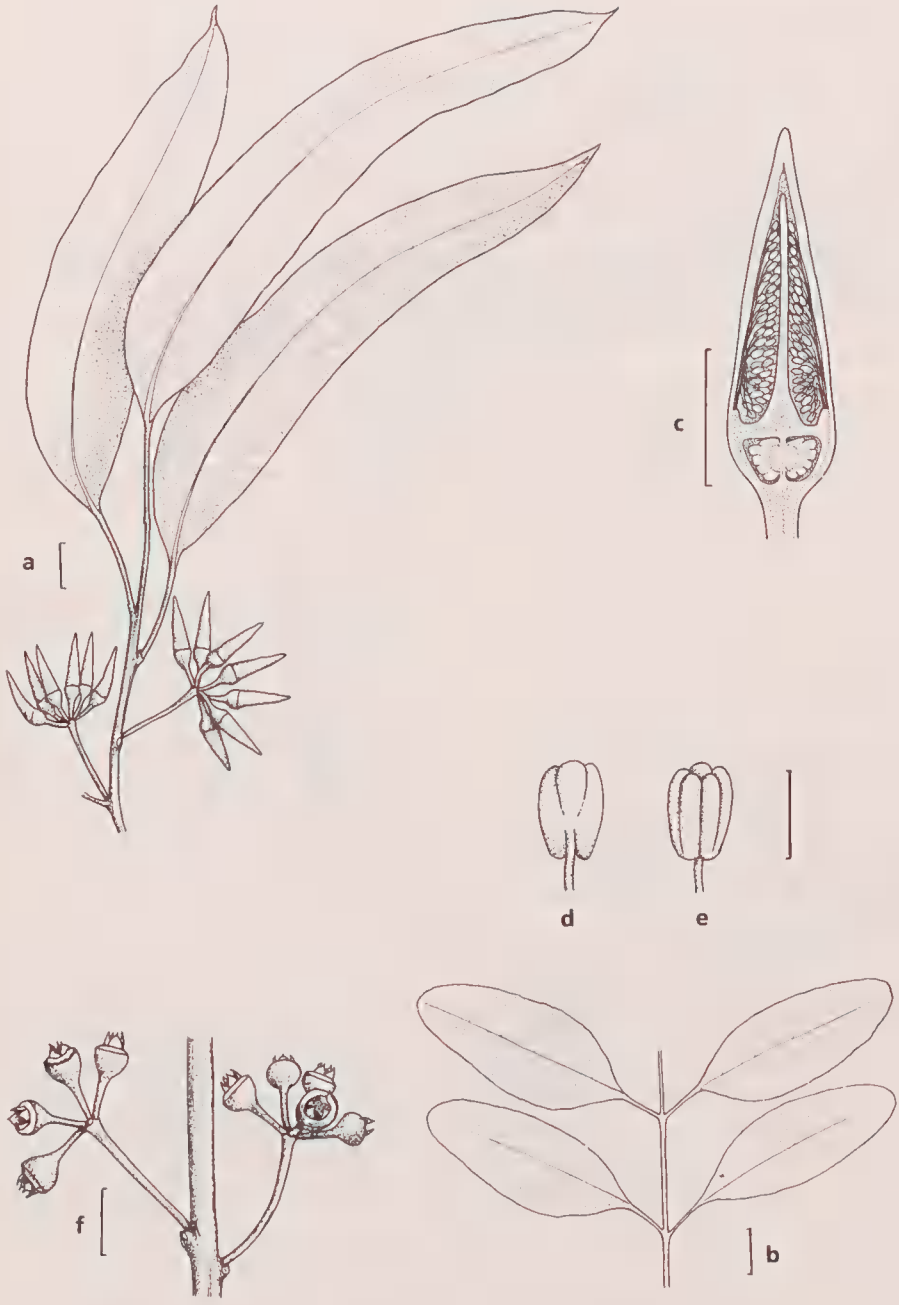

Figure 3. *E. disclusa*. **a**, adult leaves and buds. **b**, juvenile leaves. **c**, median section of bud. **d**, **e**, anthers. **f**, fruits (all from *Brooker 3776*). Scale bar: a, b, f = 1 cm; c = 5 mm; d, e = 0.5 mm.

ECOLOGY: Restricted to rocky sandstone areas, probably with somewhat impeded drainage, at elevations of 600–900 m, associated with *E. umbra* R. Baker or a related taxon.

The epithet is from the Latin *disclusus*, kept apart, referring to the wide separation of the areas of occurrence of this and species closely related to it.

CONSERVATION STATUS: 2V. Occurs in small relict populations.

SELECTED SPECIMENS (from 9 examined): QUEENSLAND: campsite on Mimosa Creek, Blackdown Tableland, *Henderson 674, Andrews & Sharpe*, 18 Apr 1971 (BRI, NSW); Mimosa Creek, Blackdown Tableland, *Blaxell 754 & Johnson*, 26 Nov 1972 (NSW).

3. Eucalyptus vicina *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. dwyeri* sed foliis juvenilibus latiores, alabastris fructibusque minoribus et calyptra rotundata distinguitur.

TYPE: NEW SOUTH WALES: North Far Western Plains: Manara Hill, *L. Johnson & D. Blaxell 431*, 16 Apr 1970 (holo NSW; iso CANB, MEL).

Mallee or tree to 10 m high. *Bark* smooth, patchy white to dark grey. No pruinosity present. *Juvenile leaves* disjunct, broad-lanceolate to ovate, obtuse or mucronate, to 7 cm long, 4 cm wide; petioles to 12 mm long. *Adult leaves* disjunct, similifacial, narrow- to broad-lanceolate, obtuse, acute or acuminate, 7–14 cm long, 1.2–3.0 cm wide; petioles flattened, 7–14 mm long; lateral veins closely to moderately spaced, irregular, at 30–50° to midrib; reticulum open, discontinuous; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles terete or angular, 4–8 mm long; pedicels terete or ribbed, 1–3 mm long. *Mature buds* ovoid, 6–8 mm long, 3–4 mm diam. *Calyptra* double, outer shed early, inner broadly conical or hemispherical, 1–1.5 times as long as hypanthium. *Stamens* all fertile; filaments irregularly erect in bud; anthers elliptical, dorsifixed, versatile, dehiscing by parallel slits. *Fruits* cup-shaped to hemispherical, 3–4-locular, 4–5 mm long, 5–6 mm diam.; calyptra scar flat, continuous with stemonophore, the two less than 0.5 mm wide together; disc flat or slightly depressed or domed, c. 1 mm wide; valves broadly triangular, obtuse, strongly exserted at 45–90°. *Seeds* semi-glossy,

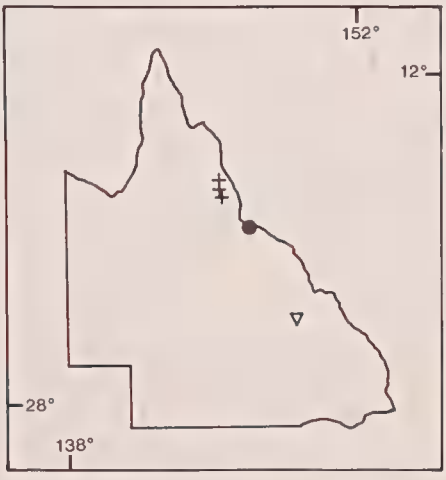

Figure 4. Distribution of *E. disclusa* (▽), *E. lockyeri* (+) and *E. paedoglauca* (●).

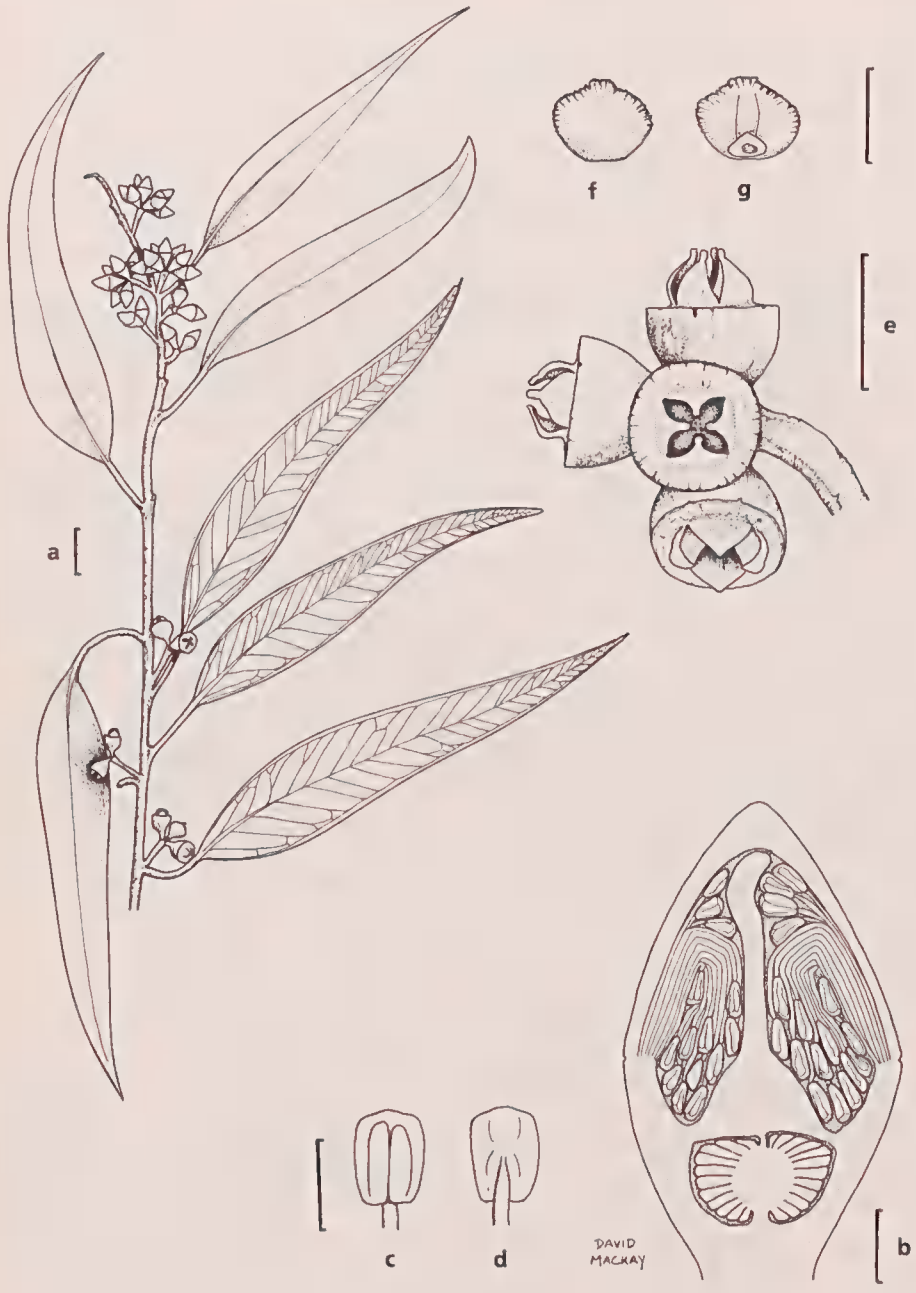

Figure 5. *E. vicina*. **a**, adult leaves with buds and fruit. **b**, median section of bud. **c**, **d**, anther. **e**, fruit. **f**, **g**, seed (a, e, f, g from *Johnson*, 25 May 1969, c, d, e from *Johnson & Blaxell 431*). Scale bar: a = 1 cm; e = 5 mm; b, c, d, f, g = 0.1 mm

charcoal-black, angular, cuboid or pyramidal with dentate fringes, deeply loosely reticulate, c. 1 mm long; hilum ventral; chaff red-brown, semi-glossy. Figure 5.

E. vicina is distinguished from *E. dwyeri* Maiden & Blakely by the broader juvenile leaves (to broad-lanceolate in the latter), the smaller fruits (fruit to 7 x 7 mm in the latter), and the rounded calyptra.

Distribution: Western New South Wales, Bourke to Lake Cargelligo, west to Mootwingee (Figure 1).

Ecology: Locally abundant on siliceous residuals through the western parts of New South Wales.

The epithet is from the Latin *vicinus*, neighbouring or closely resembling, from its resemblance to *E. dwyeri* Maiden & Blakely and other small red gums.

Conservation status: not considered to be at risk.

Selected specimens (from 30 examined): New South Wales: North Western Plains: Gunderbooka Range, *Blaxell 572, 523, 524*, 3 Nov 1971 (NSW); Mt Buckwarron, *Fatchen*, 26 Jul 1985 (NSW); 3.7 km N of Mt Grenfell, *Crisp 7888*, 17 Dec 1986 (CBG, NSW). South Western Plains: Merrimerriwa Range, *Slee 745 & Holgate*, 1 Sep 1982 (CANB, NSW); Round Hill, *Hill 112 & Johnson*, 11 Oct 1983 (NSW); 3 km W of Roto, *Pickard 1926*, 16 Mar 1973 (NSW); 16 km WSW of Lake Cargelligo, *B.G. Briggs 8028 & Johnson*, 17 Apr 1987 (NSW, CANB, MEL, PERTH). North Far Western Plains: Mootwingee Historic Site, *Johnson*, 24 May 1969 (NSW).

4. Eucalyptus lockyeri *Blaxell & K. Hill*, **sp. nov.**

Ab *E. exserta* distinguitur: discus minor elevatus, folia juvenilia late lanceolata vel ovata, folia adulta late lanceolata vel anguste ovata, folia alabastra et fructus valde glauca.

Type: Queensland: Camping reserve near 'Evelyn' homestead, NW of Ravenshoe, *D.F. Blaxell 1611*, 3 Jun 1978 (holo NSW).

Tree to 9 m high, often with short irregular bole and twisted branches. *Bark* persistent, dark grey, subfibrous or flaky on trunk and base of lower limbs; smooth, regularly shed, orange-brown, pinkish grey or grey on limbs. *Small limbs* and twigs often strongly glaucous. *Seedling leaves* shortly petiolate, oblong-obovate, opposite for few nodes. *Juvenile leaves* disjunct, petiolate, oblong or ovate, rounded, mucronate, 6–8 cm long, 3.5–4 cm wide, usually strongly glaucous. *Adult leaves* disjunct, ovate-lanceolate or lanceolate, acute or acuminate, 9–15 cm long, 2.5–5 cm wide, glaucous on new growth; petioles slightly flattened above, 12–20 mm long; lateral veins widely spaced, irregularly reticulate, at 40°–50° to midrib; intramarginal vein distinct, 1–2.5 mm from margin. *Umbellasters* axillary, 7-flowered, buds and fruits glaucous; peduncles with 2 low wings, 10–20 mm long; pedicels terete or shortly winged, 3–6 mm long. *Mature buds* 9–11 mm long, 4–5 mm diam.; calyptra evenly conical, obtuse, 2–3 times longer than hypanthium; outer calyptra scar distinct. *Anthers* all fertile; filaments erect and irregularly inflexed in bud; stamens ovoid, dorsifixed, versatile, dehiscing by slits. *Fruits* 4–5-locular, campanulate or conical, with 2–4 vertical ridges, 11–12 mm long, 9–13 mm diam.; calyptra scars and staminophore distinct, forming a narrow depressed groove at top of hypanthium; disc broad, flat or somewhat domed; valves vertically exserted, broadly triangular, acute or acuminate. *Seeds* dark brownish black, dull, angular, to 1 mm long; chaff smaller, pale brown. Figure 6.

E. lockyeri is nearest to *E. exserta* F. Muell., from which it is distinguished by the less raised disc, the broad-lanceolate to ovate juvenile leaves (linear to narrow-lanceolate in the latter), the broad-lanceolate to narrow-ovate adult leaves (lanceolate in the latter) and the strongly glaucous leaves, buds and fruits.

Figure 6. *E. lockyeri*. **a**, adult leaves and buds. **b**, median section of bud. **c**, **d**, anther. **e**, fruits (a, b, c, d from *R.W. Lockyer 108C*; e from *M.G. Lockyer 102A*). Scale bar: a, e = 1 cm; b = 5 mm; c, d = 1 mm.

DISTRIBUTION: NORTH QUEENSLAND: Restricted to several local occurrences to the north-west of Ravenshoe (Figure 4).

ECOLOGY: This species forms small almost pure stands on poor, rocky soils derived from acid volcanics and acid granites, usually on low ridges or lower slopes of higher hills.

The epithet honours Michael Lockyer of Ravenshoe, who first drew the authors' attention to this taxon.

CONSERVATION STATUS: 3R. Occurs in small populations, which are generally not in reserved areas.

SELECTED SPECIMENS (from 32 examined): QUEENSLAND: West of Herberton, crest of Great Dividing Range, *Blake 22102*, 28 Aug 1963 (BRI, NSW); near Cairns railway line, 11 miles [17.6 km] NW of Ravenshoe, *R.W. Lockyer 108 A,B,C,D*, 20 Mar 1978 (NSW); near old Evelyn homestead, N of Ravenshoe,*Brooker 6528*, 11 Oct 1979 (CANB, BRI, NSW); Diddleluma Creek, c. 7 km NW of Ravenshoe, *Blaxell 1616*, 3 Jun 1978 (NSW); Robinson Creek area east of the Ravenshoe to Tumoulin road, *Clarkson 2666*, 11 Oct 1979 (BRI, CANB, NSW); 4 miles [9.2 km], 288° from Ravenshoe, *M.G. Lockyer 102 A,B,C,D*, 26 Mar 1978 (NSW).

5. Eucalyptus parvula *L. Johnson & K. Hill*, **nom. nov.**

≡ *Eucalyptus parvifolia* Cambage, Proc. Linn. Soc. New South Wales 34: 336 (1909); nec Newberry, Flora Amboy Clays: 112 (1895) [nec F. Muell. (1859), in syn., nom. nud.].

TYPE CITATION: 'Hab – Flat land near the head of the Kybean River'.

TYPE: NEW SOUTH WALES: Southern Tablelands: Kybean River, 16 miles [26 km] E of Nimmitabel, *R.H. Cambage 1924*, 9 Feb 1908 (lecto NSW; isolecto CANB). This specimen bears a note in Cambage's hand stating 'confined to flats' (among other details). This note links the specimen to the protologue, and it is hence selected from two Cambage collections as lectotype.

A new name is required here as the combination *Eucalyptus parvifolia* is preoccupied by Newberry's fossil species.

The epithet is from the Latin *parvulus*, little, in reference to the small leaves and the generally small size of the tree in all its parts.

CONSERVATION STATUS: 2VC (Briggs & Leigh (1988)).

The *E. cinerea* species complex or 'superspecies'

The following group of three species is part of a complex of six species, the *E. cinerea* group (or superspecies). Other members not discussed here are *E. nova-anglica* Deane & Maiden, *E. triplex* L. Johnson & K. Hill, and *E. cinerea* F. Muell. ex Benth.

6. Eucalyptus cephalocarpa *Blakely*, Key Eucalyptus: 164 (1934).

TYPE CITATION: 'Specimens collected by J.H. Maiden from Dandenong Mountains, Victoria, constitute the type; while specimens collected near Ringwood, Victoria (C. Walter and R.H. Cambage), may be regarded as co-types.'

TYPE: VICTORIA: Dandenong Mtn, *J.H. Maiden*, Jan 1901 (holo NSW 233111). Blakely described this as a new species, citing *E. cinerea* F. Muell. ex Benth. var. *multiflora* Maiden (below) as a synonym.

≡ *E. cinerea* F. Muell. ex Benth. var. *multiflora* Maiden, Crit. Revis. Eucalyptus 3: 7 (1914). TYPE CITATION: Maiden cited no Type, but gave extensive notes on occurrence, mentioning 15–20 collections from the South Coast of New South Wales and eastern and central Victoria. This material represents both *E. cephalocarpa* and *E. conspicua*. TYPE: VICTORIA: Dandenong Mtn, *J.H. Maiden*, Jan 1901 (lecto NSW 233111). This specimen accords with Maiden's description, and is here designated the lectotype to fix the nomenclature as used by Blakely (above) and Chippendale (1988). We do not regard Blakely's description as a lectotypification as stated by Chippendale. This difference in interpretation entails no present or potential change of name.

= *E. pulverulenta* Sims var. *lanceolata* Howitt, Proc. Austral. Assoc. Advanc. Sci. 7: 517 (1898). TYPE CITATION: 'It occurs between the Pilot range and Beechworth (F.v.M.), near the Ovens River (C.Falk), and in the Ovens district (D.Ingle). In Gippsland I have observed it near Buchan, at Providence Ponds (between the Avon and Mitchell Rivers), near Ostler's Creek, on the Walhalla Road, between Darlimurla and Mirboo North, at Monkey Creek between Sale and Port Albert, and at Moe'. TYPE: VICTORIA: Moe, *A.W. Howitt*, 23 Apr 1898 (lecto MEL, here designated). This specimen is selected as Lectotype in order to fix the application of this name as a synonym of *E. cephalocarpa*, as the cited material also included material of *E. alligatrix* and *E. conspicua*. In their discussion of this taxon under the following name, Baker and Smith refer to inflorescences with more than three flowers and the lanceolate leaves, a statement applying principally to the *E. cephalocarpa* component. Included in *E. cinerea* var. *multiflora* by Maiden (op. cit.).

[= *E. stuartiana* F. Muell. ex Miq. var. *cordata* R. Baker & H.G. Smith, Res. Eucalypts: 105 (1902), nom. illegit. The epithet of *E. pulverulenta* var. *lanceolata*, cited as a synonym by Baker & Smith, should have been adopted in this position and rank.]

Mueller (1880) regarded both *E. alligatrix* and *E. cephalocarpa* as intermediates between *E. cinerea* (*E. pulverulenta* as used by Mueller, not as to type) and *E. bridgesiana* R. Baker (his *E. stuartiana* F. Muell.).

E. cephalocarpa is distinguished within the *E. cinerea* group by the frequently green, lanceolate, and disjunct adult leaves and the 7-flowered inflorescences.

DISTRIBUTION: Victoria, coastal drainage systems around Port Phillip Bay, east to around Moe (Figure 7).

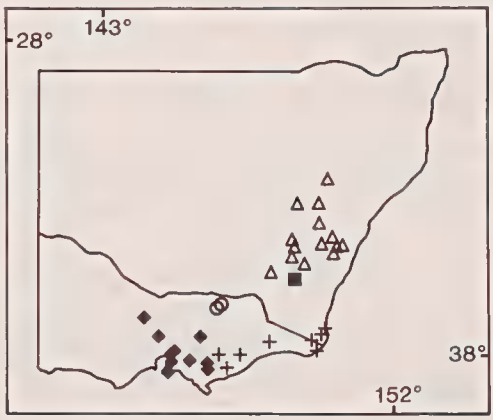

Figure 7. Distribution of *E. cephalocarpa* (◆), *E. conspicua* (+), *E. alligatrix* (○), *E. cinerea* (△) and *E. triplex* (■).

ECOLOGY: Scattered but locally frequent, usually on low-lying, often swampy sites.

CONSERVATION STATUS: Not considered to be at risk.

SELECTED SPECIMENS (from 32 examined): VICTORIA: 6 miles [9.6 km] SSE of Rosedale, *Willis*, 2 Feb 1972 (NSW, MEL 502307); 3.6 km W of Bunyip River bridge on Princes Hwy, *Weston 426*, 2 Jul 1984 (NSW, CANB, CBG, K, MEL); 14 km E of Gembrook, *Crisp 7130*, 21 Jul 1983 (CBG, AD, MEL, NSW); 6 miles [9.6 km] S of Woori Yallock, *Brooker 4376*, 13 Feb 1974 (CANB, NSW); 1.5 km from Montrose towards Lilydale, *Hill 1438 & Johnson*, 21 Feb 1986 (NSW); 6 km SW of Gisbourne, *Brooker 6990*, 1 Oct 1981 (CANB, MEL, NSW); Flinders, *Meebold*, Jan 1937 (NSW).

7. Eucalyptus conspicua *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. cinerea* umbellastris 7-floris et foliis adultis lanceolatis petiolatisque distinguitur. Ab *E. cephalocarpa* foliis pruinosis et formae plus neotenicae differt.

TYPE: NEW SOUTH WALES: South Coast: 0.7 km S of Ireland Timms Road on Princes Hwy (37°16'S 149°48'E), *K. Hill 1359 & L. Johnson*, 17 Feb 1986 (holo NSW; iso CANB, MEL, PERTH).

Tree to 10 m, often of twisted, spreading habit. *Bark* persistent to smaller branches, shortly fibrous to almost stringy. *Juvenile leaves* opposite, sessile, orbicular, apiculate, rounded or cordate basally, glaucous, to 7 cm long, 6 cm wide. *Adult leaves* opposite, rarely slightly disjunct, lanceolate, sometimes ovate-lanceolate, acuminate, glaucous, 7–20 cm long, 1.5–4.0 cm wide; petioles 0–23 mm long; lateral veins at c. 30° to midrib, well-spaced, anastomosing; intramarginal vein usually indistinct, sometimes evident. *Umbellasters* axillary, 7- or rarely 3-flowered; peduncles terete or slightly angled, 5–12 mm long; pedicels 0–2 mm long. *Mature buds* glaucous, 7–9 mm long, 5–6 mm diam.; hypanthium conical; calyptra rounded or conical, obtuse or acute, less than half as long as hypanthium. *Stamens* all fertile; filaments erect then incurved and inflexed in bud; anthers ovate, emarginate, dorsifixed, versatile, dehiscing by slits, widely opening. *Fruits* glaucous, conical or cup-shaped, 7–9 mm long, 6–7 mm diam., 3- or 4-locular; calyptra scar c. 0.5 mm wide, discontinuous with disc and hypanthium; disc 1.0–1.5 mm wide, flat or slightly raised; valves broadly triangular, flat or slightly exserted. *Seeds* dull, dark brown, cuboid, rounded, 1.0–1.5 mm long; chaff brown, linear, to 1.5 mm long. Figure 8.

E. conspicua has previously been included in *E. cinerea*, from which it differs in the 7-flowered umbellasters and lanceolate, petiolate adult leaves. It has also been confused with *E. cephalocarpa*, which is also 7-flowered but is considerably less glaucous and regularly attains a fully adult foliage canopy in contrast to the neotenous adult foliage of both *E. cinerea* and *E. conspicua*.

DISTRIBUTION: NEW SOUTH WALES: South Coast, Narrabarba southwards. VICTORIA: coastal regions, north and east of Mallacoota (Figure 7).

ECOLOGY: Locally frequent on poorer soils, often on hillsides with impeded drainage or on heathy flats.

Hybrids are known with *E. ignorabilis* L. Johnson & K. Hill.

The epithet is from the Latin *conspicuus*, striking or conspicuous, referring to the distinctive overall glaucous colour of the tree, which clearly distinguishes it from all other vegetation in its habitat.

CONSERVATION STATUS: 3R. Although this species is generally in small and scattered populations, the habitat is unlikely to be under threat of development.

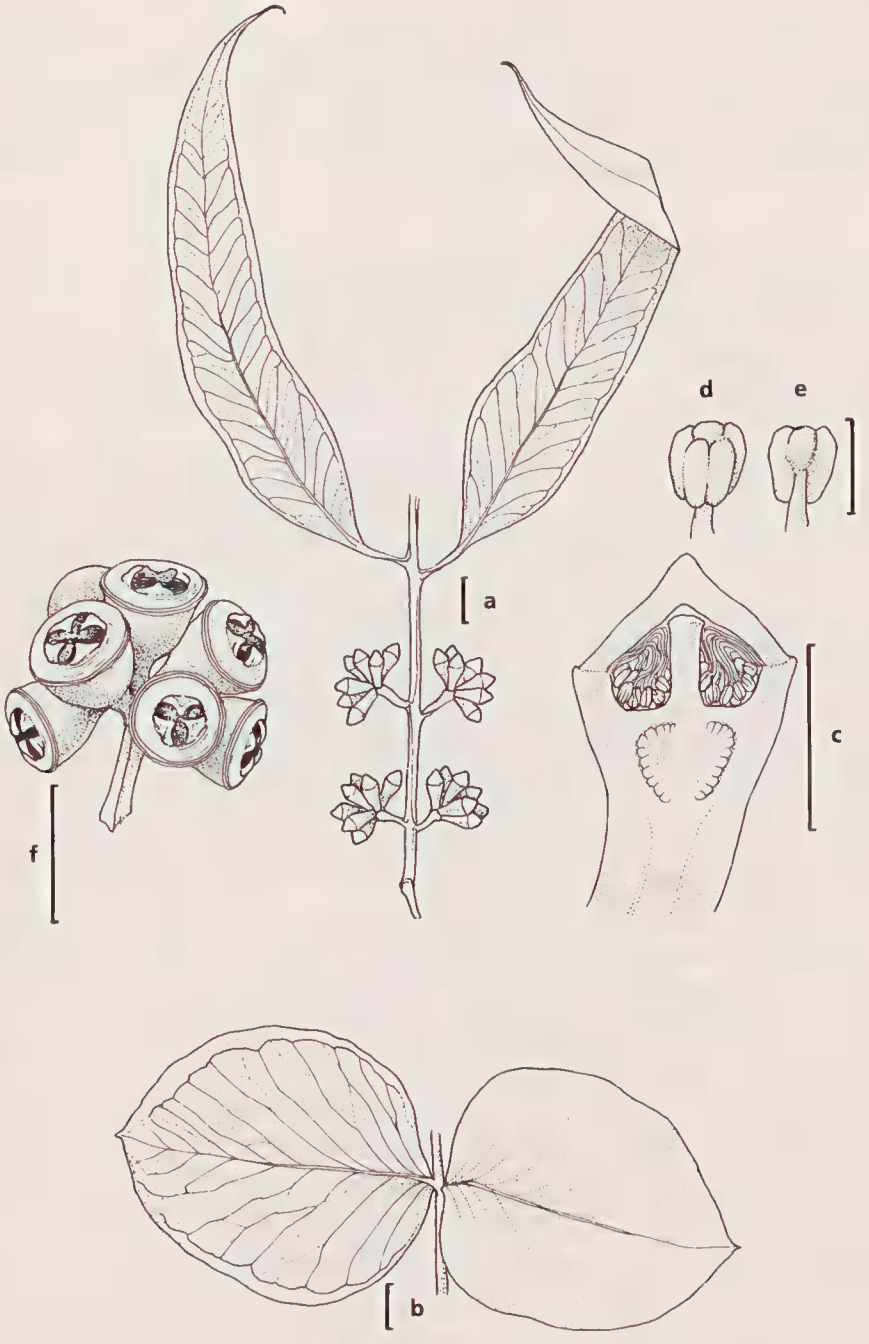

Figure 8. *E. conspicua*. **a**, adult leaves and buds. **b**, juvenile leaves. **c**, median section of bud. **d**, **e**, anther. **f**, fruit (all from *Wakefield 1*). Scale bar: a, b, f = 1 cm; c = 5 mm; d, e = 0.5 mm.

Selected specimens (from 31 examined): New South Wales: South Coast: 4 km S of Narrabarba, *Crisp 4028, Telford & Parker*, (CBG, BISH, CANB, NSW); near Timbillica, *Wakefield 1*, Jun 1920 (NSW). Victoria: 11.2 miles [18 km] E of Mt Drummer, *Brooker 4413*, (CANB, NSW); 6.9 km from Monument Road on Tara Link Road, *Hill 1385 & Johnson*, 18 Feb 1986 (NSW, CANB, MEL, PERTH); 18 km E of Stratford on hwy, *Hill 1396 & Johnson*, 18 Feb 1986 (NSW, CANB, MEL, PERTH); 5.1 km W of Seaton, *Hill 1404 & Johnson*, 19 Feb 1986 (NSW, CANB, MEL, PERTH).

8. Eucalyptus alligatrix *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. cinerea* et *E. cephalocarpa* combinatione umbellastrarum triflorarum et foliorum lanceolatorum saepe disjunctorum distinguitur.

Type: Victoria: Big River, near junction with Taponga River, SW of Jamieson, *L. Johnson 7675*, 24 Apr 1973 (holo NSW).

Tree to 20 m tall. *Bark* persistent to smaller branches, brown, subfibrous, branchlets more or less glaucous. *Juvenile leaves* opposite for many nodes, sessile, orbicular, cordate, apiculate, strongly glaucous, to 4 cm long, 4 cm wide. *Adult leaves* disjunct or opposite, lanceolate, sometimes ovate-lanceolate, acute or acuminate, strongly glaucous, 7–17 cm long, 1.3–3.5 cm wide; petioles 6–18 mm long, leaves occasionally sessile; venation indistinct, lateral veins at 20–45° to midrib, well-spaced, anastomosing; intramarginal vein sometimes distinct, 1–2 mm from margin. *Umbellasters* axillary, 3-flowered; peduncles terete or slightly flattened, 4–6 mm long. *Buds* and fruit sessile. *Mature buds* strongly glaucous, 6–8 cm long, c. 4 mm diam.; hypanthium conical; calyptra slightly shorter than hypanthium, conical, obtuse. *Stamens* all fertile; filaments initially erect then inflexed in bud; anthers ovate, emarginate, dorsifixed, versatile, dehiscing by slits and widely opening. *Fruits* cup-shaped or broadly conical, glaucous, 3- or 4- locular, 5–7 mm long, 4–6 mm diam.; calyptra scar distinct, 0.5–1.0 mm wide, continuous with hypanthium; disc c. 1 mm wide, flat or slightly raised; valves prominently exserted, broadly triangular. *Seeds* dull, very dark brown, cuboid, to 1 mm long; chaff similar, smaller and thinner. Figure 9.

E. alligatrix has previously been recognised as an intermediate taxon between *E. cinerea* and *E. cephalocarpa*, from both of which it is distinguished by the combination of the 3-flowered umbellasters and the lanceolate, often disjunct adult leaves. The populations are disjunct and clearly distinguishable (*E. cinerea* does not occur in Victoria).

Distribution: Victoria: A small area between Beechworth and the Ovens River (Figure 7).

Ecology: Locally frequent on lower slopes of valleys, with *E. robertsonii* Blakely.

The epithet is from the Latin, *alligatrix*, she who binds together, referring to the intermediate position of this taxon, forming a link between *E. cinerea* and *E. cephalocarpa*. There is no etymological connection between this Latin word (of which the masculine equivalent is *alligator*) and the name of certain crocodilians. The stress is on the 'a' as in 'matrix'.

Conservation status: 2V. Most populations are on agricultural land or road verges, with no guarantee of continued preservation. The habitat is on agriculturally useful land, and considerable areas of this taxon have already probably been cleared.

Selected specimens (from 14 examined): Victoria: 7.2 km from Beechworth towards Yackandandah, *Hill 1431 & Johnson*, 20 Feb 1986 (NSW, CANB, MEL, PERTH; 8 km from Beechworth towards Chiltern, *Crisp 7101*, 27 Feb 1983 (CBG, MEL, NSW); Ovens River, *Falx*, 1879 (MEL, NSW).

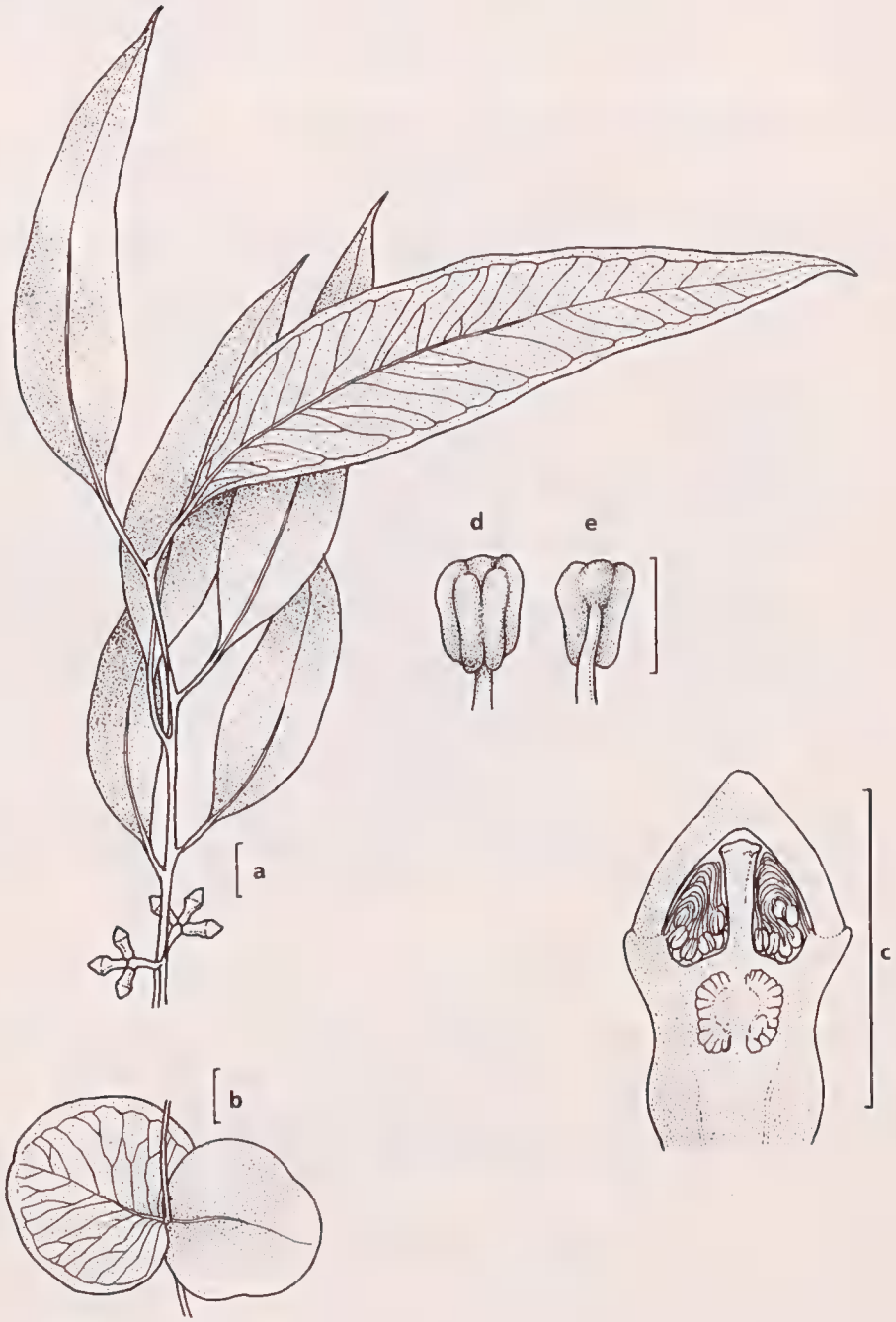

Figure 9. *E. alligatrix*. **a**, adult leaves and buds. **b**, juvenile leaves. **c**, median section of bud. **d**, **e**, anther (all from *Johnson 7675*). Scale bar: a, b = 1 cm; c = 5 mm; d, e = 0.5 mm

9. Eucalyptus rubida *Deane & Maiden*, Proc. Linn. Soc. New South Wales 24: 456 (1899).

TYPE CITATION: None cited. Notes on the range of the species mention 'Mt Kosciusko, Jindabyne, Adaminaby, Delegate to Bombala and Cooma, Michelago, Queanbeyan; northerly nearly as far as Moss Vale, Westerly as far as Sunny Corner and the tributaries of the Turon. Extends also to Victoria and South Australia (St. Vincent's Gulf).'

TYPE: NEW SOUTH WALES: Southern Tablelands: Jindabyne, *J.H. Maiden*, 1.1898 (lecto NSW, 2 sheets). Designated by Maiden (Crit. Revis. Eucalyptus 3: 123 (1916)).

Four subspecies may be recognised on the basis of systematic regional variations.

Key to the subspecies

1 Umbellasters 3-flowered
  2 Juvenile leaves orbicular; trunk smooth to base
    3 Juvenile leaves mostly < 4 cm diam.; coppice shoots terete ..... **9A.** subsp. **rubida**
    3* Juvenile leaves mostly > 5 cm diam.; coppice shoots quadrangular ..... **9B.** subsp. **canobolensis**
  2* Juvenile leaves elliptical; trunk usually with a short, thick black stocking ..... **9C.** subsp. **barbigerorum**
1* Umbellasters 7-flowered ..... **9D.** subsp. **septemflora**

9A. Eucalyptus rubida *Deane & Maiden* subsp. **rubida**

≡ *E. gunnii* Hook. f. var. *rubida* (Deane & Maiden) Maiden, Proc. Linn. Soc. New South Wales 26: 577 (1901).

[*E. granularis* Sieber ex Benth., Fl. Austral. 3: 240 (1867), in syn., nom. nud.]

[*E. viminalis* Labill. var. *microcarpa* F. Muell. ex Maiden, Crit. Revis. Eucalyptus 3: 112 (1916), in syn., nom. nud.]

[*E. fabrorum* Behr ex Maiden, Crit. Revis. Eucalyptus 3: 112 (1916), in syn., nom. nud; in part.]

This taxon was included in *E. viminalis* prior to Deane & Maiden's circumscription.

Bark smooth to base. Adult and juvenile leaves, buds and fruits small. Juvenile leaves orbicular.

Intergrading populations with *E. dalrympleana* Maiden subsp. *dalrympleana* are scattered through southern N.S.W. and Victoria, and hybrids are recorded with *E. aggregata* Deane & Maiden, *E. aromaphloia* Pryor & Willis, *E. corticosa* and *E. cinerea*.

CONSERVATION STATUS: not considered to be at risk.

9B. Eucalyptus rubida *Deane & Maiden* subsp. **canobolensis** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie *rubida* foliis adultis juvenilibusque majoribus, alabastris fructibusque majoribus, et habitu minore differt.

TYPE: NEW SOUTH WALES: Central Tablelands: Mt Canobolas, Orange, *J.L. Boorman*, Jan 1908 (holo NSW).

Tree to 10 m tall, of spreading form. Bark smooth to base, white, shedding in ribbons. Twigs, leaves and inflorescences strongly glaucous when young. Juvenile leaves opposite for many nodes, broad-ovate to orbicular, sessile, apically rounded, sometimes shortly apiculate, to 11 cm long, 7 cm wide; juvenile shoots 4-angled. Adult leaves

disjunct, lanceolate, 10–16 cm long, 1.5–3.3 cm wide; petioles 12–35 mm long; lateral veins well-spaced, anastomosing, at c. 45° to midrib; intramarginal vein distinct, 1–2 mm from margin. Umbellasters axillary, 3-flowered; peduncles distinctly flattened, 6–9 mm long; buds and fruits sessile. Mature buds oval, 5–7 mm long, 3–4 mm diam.; calyptra double, outer shedding early, inner obtuse, slightly shorter than hypanthium. Fruit 3–4-locular, cup-shaped, 7–9 mm long, 6–8 mm diam.; disc c. 2 mm wide, domed; valves exserted, broadly triangular, obtuse, angled inward at c. 60° to vertical.

Subspecies *canobolensis* differs from subsp. *rubida* in the larger adult and juvenile leaves, the larger buds and fruits, and the smaller overall tree size. The two subspecies intergrade on the lower slopes of Mt Canobolas, and only subsp. *rubida* occurs elsewhere in the district.

Distribution: New South Wales: Central Tablelands, known only from the summit and higher slopes of Mt Canobolas, near Orange.

Ecology: Locally abundant with *Eucalyptus pauciflora* Sieber ex Sprengel in subalpine woodland with *Poa* understorey, at altitudes above 1100 m.

The epithet *canobolensis* is derived from that of Mt Canobolas, which is the only known habitat of the subspecies. The spelling is deliberate, and a 'correction' would be both contrary to the Code and very disagreeable in a Latin context.

Conservation status: 2VC. Although parts of the only known population are reserved, the entire area is subject to disturbance and frequent wildfires, both of which pose a considerable threat to the continuing viability of the population.

Selected specimens (from 10 examined): New South Wales: Central Tablelands: near top of Mt Canobolas, *Garden*, 1 Oct 1949 (NSW); Mt Canobolas, *Johnson*, 15 Aug 1953 (NSW 24996); summit of Mt Canobolas, *Brooker 3061*, 17 May 1971 (CANB, NSW).

9C. Eucalyptus rubida *Deane & Maiden* subsp. **barbigerorum** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie *rubida* foliis juvenilibus ellipticis et tibiali crasso nigro distincto corticis persistens partem inferam trunci investente differt.

Type: New South Wales: Northern Tablelands: 14.1 km from Wandsworth towards Tingha, *K. Hill 2117*, 29 Aug 1986 (holo NSW, iso BRI, CANB, PERTH).

Tree to 15 m tall. Bark smooth, white, shedding in ribbons, with a thick dark grey or black stocking to 1–2 m on the lower trunk. Twigs, leaves and inflorescences glaucous when young. Juvenile leaves opposite for many nodes, ovate to elliptical, sessile, usually shortly apiculate, to 14 cm long, 8 cm wide; juvenile shoots terete. Adult leaves disjunct, lanceolate, 10–22 cm long, 1.3–3.3 cm wide; petioles 12–33 mm long; lateral veins well-spaced, anastomosing, at c. 45° to midrib; intramarginal vein distinct, 1–2 mm from margin. Umbellasters axillary, 3-flowered; peduncles terete, 5–8 mm long; buds and fruit sessile. Mature buds oval, 5–7 mm long, 3–4 mm diam.; calyptra double, outer shedding early, inner obtuse, slightly shorter than hypanthium. Fruits 3–4-locular, cup-shaped, 7–9 mm long, 6–8 mm diam.; disc c. 2 mm wide, domed; valves broadly triangular, obtuse.

Subspecies *barbigerorum* differs from subsp. *rubida* in the elliptical juvenile leaves, and the distinct thick, black stocking of persistent bark on the lower trunk.

Distribution: New South Wales: Northern Tablelands, known from scattered populations to the west of Glen Innes and Guyra, and in the Moonbi Ranges between Woolbrook and Nundle.

Ecology: Locally abundant or dominanting in grassy woodland on deep, fertile clay-loam soils, often with *E. melliodora* Cunn. ex Schauer, *E. viminalis* Labill., *E. dalrympleana* Maiden subsp. *heptantha* L. Johnson and *Angophora floribunda* (Smith) Sweet.

Considerable intergradation occurs with *E. dalrympleana* subsp. *heptantha* in country north-west of Guyra and north of Glen Innes.

The epithet is from the Latin *barbigerorum*, 'of the beard-bearing ones'; in allusion to the occurrence of this taxon in 'the land of the beardies', referring to the bearded pioneers of European settlement in the area.

Conservation status: 3V. Most populations are on agricultural land or road verges, with no guarantee of continued preservation. The habitat is on agriculturally valuable land, and considerable areas of this taxon have undoubtedly already been cleared.

Selected specimens (from 12 examined): New South Wales: Northern Tablelands: 8.6 km from Wandsworth towards Tingha, *Hill 2118*, 29 Aug1986 (BRI, CANB, NSW, PERTH); 20.1 km E Tingha on Guyra road, *Hill 1293, 1294 & Johnson*, 11 Sep 1985 (NSW); 12.1 km from Glen Innes on Inverell road, *Hill 2758, Johnson & Weston*, 20 Oct 1987 (NSW); 20 miles [32 km] NW of Guyra, *Johnston & Chippendale 655, 656*, 14 Jun 1968 (CANB, NSW); near Moredun Creek, between Tingha and Guyra, *Johnson & McGillivray 2445*, 21 Sep 1966 (NSW); F.R. 45231, Parish Vernon, County Parry [about 3 km SE of Woolbrook, Moonbi Range], *Simon 34*, 18 July 1913 (NSW).

9D. Eucalyptus rubida *Deane & Maiden* subsp. **septemflora** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspeciebus aliis umbellastris 7-floris distinguitur.

Type: Victoria: 3 km N of Mt Beauty North on Wodonga road, *K. Hill 1430 & L. Johnson*, 20 Feb 1986 (holo NSW).

Tree to 25 m tall. Bark smooth, white, grey and reddish, shedding in ribbons. Twigs, leaves and inflorescences glaucous when young. Juvenile leaves opposite for many nodes, orbicular, sessile, to 8 cm long, 8 cm wide; juvenile shoots terete. Adult leaves disjunct, lanceolate, 8–22 cm long, 9–25 mm wide, petioles 10–30 mm long; lateral veins well-spaced, anastomosing, at c. 45° to midrib; intramarginal vein distinct, 1–2 mm from margin. Umbellasters axillary, 7-flowered; peduncles terete, 5–8 mm long; buds and fruit sessile, or pedicels to 2 mm long. Mature buds oval, 5–7 mm long, 3–4 mm diam.; calyptra double, outer shedding early, inner obtuse, slightly shorter than hypanthium. Fruits 3–4-locular, cup-shaped, 5–7 mm long, 5–8 mm diam.; disc c. 2 mm wide, domed; valves broadly triangular, obtuse.

Distinguished by the 7-flowered umbellasters.

Distribution: known from valleys on the north-western fall of the main divide, from the upper Tumut to the upper Kiewa valleys.

Ecology: A taxon of open grassy woodlands on broad, cold flats, frequently in association with *E. pauciflora*.

Extensive intergradation occurs with subsp. *rubida* where the ranges meet.

Conservation status: 3V. Most populations were on reasonably fertile, flat and readily cleared land, and much of this taxon has been cleared for grazing.

Specimens examined: New South Wales: Southern Tablelands: no collections, presence of this taxon reported by L.D. Pryor (pers. comm.). Victoria: Tawonga, *Gregson*, 15 Nov 1953 (NSW); 17 miles [27 km] by road from Wodonga towards Bogong, *Brooker 4357*, 11 Feb 1974 (CANB, NSW).

10. Eucalyptus ignorabilis *L. Johnson & K. Hill*, **sp. nov.**

Species *E. corticosae* et *E. aromaphloiae* affinis sed combinatione characterum sequentium distinguitur: folia juvenilia haud glauca, petiolata, anguste elliptica vel late lanceolata.

TYPE: VICTORIA: 4.6 km W of Seaton, *K. Hill 1401 & L. Johnson*, 19 Feb 1986 (holo NSW; iso CANB, MEL, PERTH).

Tree to 20 m tall. *Bark* persistent to smaller branches, thick, shortly fibrous to almost stringy, grey-brown to red-brown, smooth above, grey to grey-brown, shedding in short ribbons. *Juvenile leaves* opposite for many nodes, grey-green, at first sessile and lanceolate, to 5 cm long, 0.8 cm wide, quickly becoming petiolate, narrow-elliptical or broad-lanceolate, to 9 cm long, 5 cm wide. *Adult leaves* disjunct, lanceolate, dull grey-green, 8–18 cm long, 1.2–2.8 cm wide; petioles 6–18 mm long; lateral veins at c. 45° to midrib; intramarginal vein distinct, 1–2 mm from margin. *Umbellasters* axillary, 7-flowered; peduncles terete or angular, 5–8 mm long; pedicels terete, 1–3 mm long (buds rarely sessile). *Mature buds* ovoid, 4–6 mm long, 2–3 mm diam.; calyptra double, outer shedding early, inner hemispherical to conical, sometimes apiculate, slightly shorter than hypanthium. *Fruits* mainly 3-locular, sometimes 4-locular, cup-shaped or campanulate, 4–6 mm long, 4–6 mm diam.; disc c. 1 mm wide, flat to raised; valves broadly triangular, obtuse, angled inwards at c. 45°.

This species differs from both *E. corticosa* L. Johnson and *E. aromaphloia* Pryor & Willis in the non-glaucous, petiolate, narrow-elliptical or broad-lanceolate juvenile leaves. The former has non-glaucous, narrow-lanceolate, petiolate juveniles, while the latter has sessile, glaucous, ovate juveniles. Other as yet unnamed populations differing in other respects occur in other parts of Victoria.

DISTRIBUTION: South Coast of New South Wales, south from about Narrabarba, through coastal Gippsland in Victoria, west to around Morwell (Figure 10).

ECOLOGY: Sporadic and local, usually in small stands in low swampy sites along minor drainage lines, often fringing small open areas of sedgeland.

The epithet is from the Latin *ignorabilis*, unknown, in reference to the inclusion of this taxon in the broader concept of *E. aromaphloia* until now. Its recognition clarifies the distinctness of *E. corticosa*, which is now seen to be confined to the upper Cudgegong River valley east of Rylstone, N.S.W.

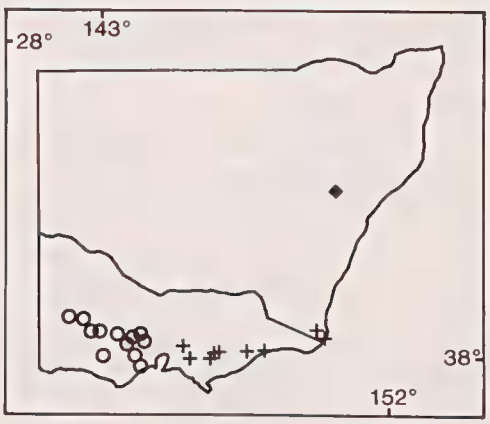

Figure 10. Distribution of *E. ignorabilis* (+), *E. corticosa* (◆) and *E. aromaphloia* sens. lat. (○).

CONSERVATION STATUS: 3R. Although this species is generally in small and scattered populations, the habitat is unlikely to be under threat of development.

SELECTED SPECIMENS (from 19 examined): NEW SOUTH WALES: South Coast: junction of Imlay Creek and Wallagaraugh River, *Crisp 3583*, 27 Oct 1977 (CBG, CANB, NSW); Dinner Creek, 8 miles [13 km] N of the Victorian Border, *Johnson*, 18 Apr 1960 (NSW 54082, CANB); Merrica River, Nadgee Nature Reserve, *Olsen 3100, 3102*, 28 Dec 1977 (NSW). VICTORIA: Near Cunningham [now Lakes Entrance], *St John*, 5 Jan 1911 (NSW); 3.6 km S of Princes Highway on Redcourt Lane (9 km W of Bairnsdale), *Hill 1392 & Johnson*, 18 Feb 1986 (NSW, CANB, MEL, PERTH); Walhalla, *Johnson*, 21 Jan 1967 (NSW); Driffield, *Brooker 5129, 5230* 5 May 1976 (CANB, NSW).

11. Eucalyptus paedoglauca *L. Johnson & D. Blaxell*, **sp. nov.**

Ab *E. drepanophylla* distinguitur: folia juvenilia ovata et glauca, alabastra fructusque plerumque majores.
TYPE: QUEENSLAND: Mt Stuart, ½ km from summit on track to radio repeater (19°21'S, 146°47'E), *K. Hill 1167, L. Johnson & D. Blaxell*, 19 Aug 1984 (holo NSW; iso BRI, CANB, K, PERTH).

Tree to 10 m tall. *Bark* persistent to smaller branches, hard black 'ironbark', smooth, yellowish white on branches less than 2 cm diam. *Juvenile leaves* disjunct, ovate to oblong-elliptical, glaucous, to 12 cm long, 7 cm wide; petioles thick, to c. 10 mm long. *Adult leaves* disjunct, similifacial, lanceolate, acute, 8–13 cm long, 12–30 mm wide; petioles to 17 mm long; lateral veins moderately spaced; intramarginal vein continuous, ± distinct, 0.5–1.0 mm from margin. *Inflorescences* simple or compound, terminal or axillary; umbellasters 3–7-flowered; peduncles ± angular, 4–9 mm long; pedicels ± flattened, 2–4 mm long. *Mature buds* ovoid, c. 6 mm long, c. 4 mm diam.; calyptra hemispherical to convex-conical, broadly apiculate, slightly shorter than hypanthium. *Fruits* cup-shaped, 4–5-locular, c. 7 mm long, 6 mm diam.; calyptra scar flat, ± 0.5 mm wide; stemonophore flat, ± 0.5 mm wide; disc ± vertically depressed, c. 1 mm wide; valves acute, basally enclosed, apically ±vertically exserted. Figure 11.

E. paedoglauca is distinguished from *E. drepanophylla* F. Muell. ex Benth. by the ovate, glaucous juvenile leaves. The buds and fruits also tend to be larger in *E. paedoglauca*.

DISTRIBUTION: At present known only from around the summit of Mt Stuart, near Townsville (Figure 4).

ECOLOGY: Locally abundant in grassy woodland with *E. exserta* F. Muell. on skeletal soils over trachyte on the broad crest of a high coastal hill (elevation about 500 m).

The epithet is from the Greek *pais, paidos*, a child or youth, and *glaukos*, pale blue or grey, alluding to the glaucous juvenile leaves.

CONSERVATION STATUS: 2VC. Known only from the type population.

SELECTED SPECIMENS (from 5 examined): QUEENSLAND: about 100 m below the summit of Mt Stuart, near Townsville, *Blaxell 2074, 2075, 2076*, 4 Sep 1983 (NSW); below summit of Mt Stuart, near Townsville, *Brooker 8958*, 30 Apr 1985 (CANB, NSW).

12. Eucalyptus caleyi *Maiden*, Proc. Linn. Soc. New South Wales 30: 512 (1906).

TYPE CITATION: Maiden cited seven collections in the protologue without specifying a type. He did however refer to one ('Tingha, Boorman, 6.1904') as having 'fruits less pear-shaped than the type'. He later designated 'Howell, N.S.W. (J.H.M and J.L. Boorman)' as the type (Crit. Revis. Eucalyptus 2: 99, legend to plate 56 (1910)), and had labelled this specimen 'Type'. This amounts to lectotypification.

TYPE: NEW SOUTH WALES: North Western Slopes: Howell, *J.H. Maiden & J.L. Boorman*, Aug 1905 (lecto NSW; isolecto G, K, L).

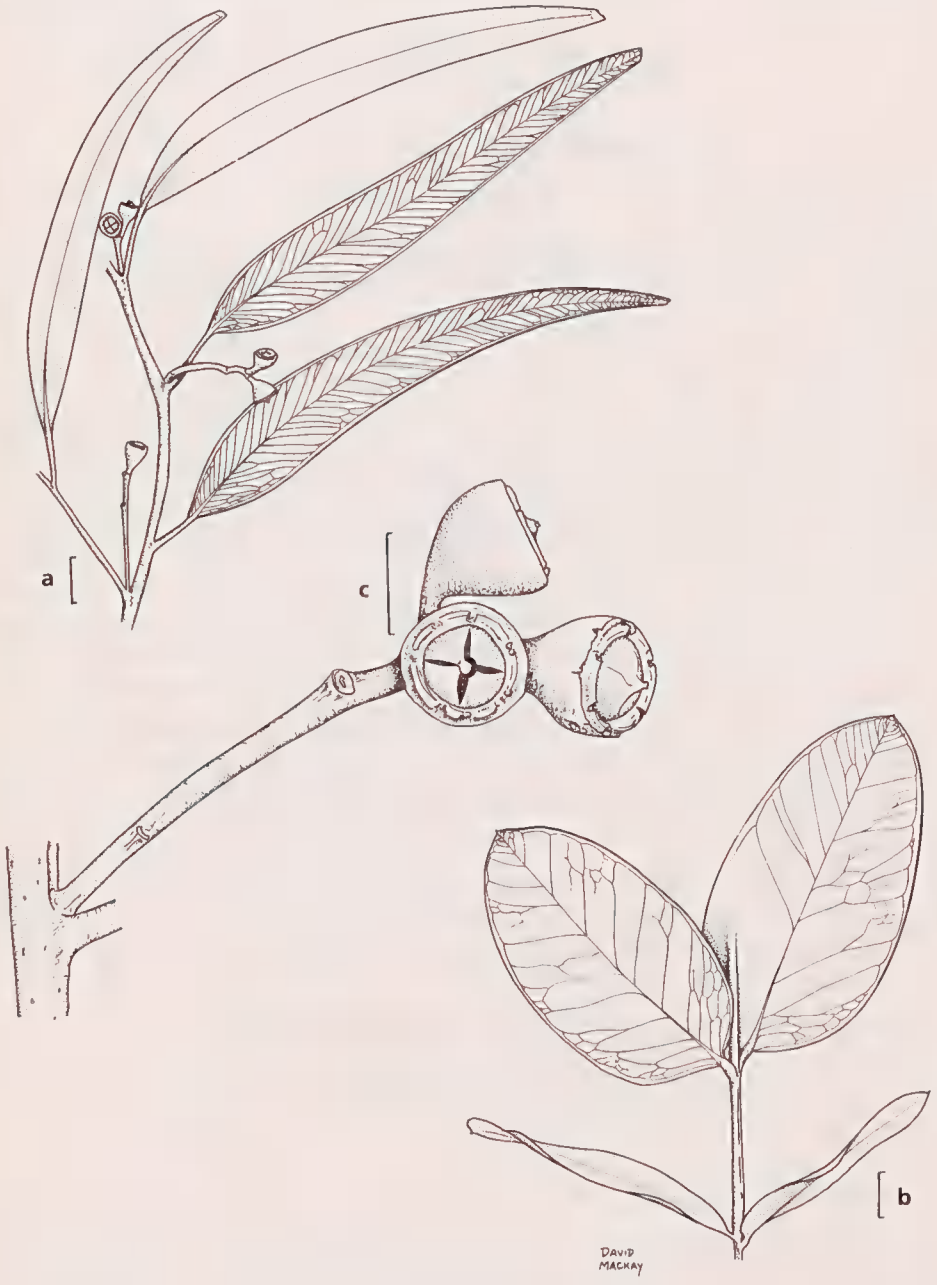

Figure 11. *E. paedoglauca*. **a**, adult leaves and fruits. **b**, juvenile leaves. **c**, fruits (all from *Hill 1167, Johnson & Blaxell*). Scale bar: a, b = 1 cm; c = 5 mm.

Tree to 25 m. *Bark* persistent throughout, ironbark. *Juvenile leaves* disjunct after about the 5th node, petiolate, ovate to orbicular, glaucous, to 6 cm long, 6 cm wide. *Adult leaves* disjunct, similifacial, glaucous, lanceolate to broad-lanceolate, 5–10 cm long, 15–40 mm wide; petioles 15–25 mm long. *Inflorescences* simple, axillary, often but not always aggregated on leafless shoots; umbellasters 7-flowered; peduncles 12–25 mm long; pedicels 5–10 mm long. Buds glaucous, rhomboid to shortly fusiform, 6–9 mm long, 4–5 mm diam.; outer calyptra shedding early; outer stamens infertile; filaments regularly inflexed; anthers adnate, cuboid, oblique to filaments, dehiscing through terminal pores. *Fruits* ovoid to pyriform, glaucous, 6–12 mm long, 5–8 mm diam.; stemonophore flat, usually persistent; disc steeply depressed. *Seeds* ovoid, shallowly regularly pitted, grey-brown; hilum ventral.

Two subspecies are recognised on differences in fruit size and shape.

Key to the subspecies

1 Fruits rounded ..... **12A.** subsp. **caleyi**
1* Fruits quadrangular..... **12B.** subsp. **ovendenii**

12A. Eucalyptus caleyi *Maiden* subsp. **caleyi**

= *Eucalyptus leucoxylon* F. Muell. var. *pallens* Benth., Fl. Austral. 3: 210 (1867).

Type citation: 'New England, C. Stuart.' Type: holo K.

≡ *E. sideroxylon* A. Cunn. ex Woolls var. *pallens* (Benth.) Rehder, Cycl. Amer. Hort. 2: 552 (1900). Included in *E. caleyi* by Maiden in the protologue.

= *E. coerulea* R. Baker & H.G. Smith, Res. Eucalypts ed. 2: 271 (1920). Type citation: ' Habitat. - Murrumbo, New South Wales.' Type: New South Wales: Central Tablelands: Murrumbo, *R.T. Baker*, Dec 1893 (lecto NSW; here designated). This specimen was annotated *E. coerulea* by Baker, and bears leaves, buds, flowers and fruit.
Chippendale (1988) erroneously cites a 1900 collection by Baker as holotype, but the application of the name is not affected. Baker and Smith at first regarded the material from this area as equivalent to Bentham's *E. leucoxylon* var. *pallens*, without seeing the type of that taxon (at the same time, they also independently made the combination *E. sideroxylon* var. *pallens*, Res. Eucalypts: 161 (1902), presumably in ignorance of Rehder's earlier publication, as cited above). They later reconsidered, regarding the two as distinct taxa when describing *E. coerulea* as a new species. Maiden included both in *E. caleyi* (Crit. Revis. Eucalyptus 7: 14).

Distinguished by the non-angular, smaller fruits (less than 10 mm long) (Figure 12).

Subsp. *caleyi* occurs in grassy or dry sclerophyll woodlands on shallow, often skeletal, soils on stony rises or slopes. It is restricted to the lower parts of the tablelands and the Western Slopes, from around Milmerran in Queensland south to the Goulburn River Valley in New South Wales (Figure 13). The single specimen recorded from the North Western Plains is from a characteristic Western Slopes habitat.

Hybrids are recorded with *E. dealbata* A. Cunn. ex Schauer, *E. nubila* Maiden & Blakely, *E. crebra* F. Muell., *E. microcarpa* (Maiden) Maiden, *E. albens* Benth. and *E. melliodora* A. Cunn. ex Schauer.

Conservation status: not considered to be at risk.

Selected specimens (from 71 examined): New South Wales: Northern Tablelands: 26 miles [42 km] W of Guyra, *McKie G*, 21 Sep 1927 (NSW); 40.3 km NW of Uralla on Bundarra road, *Chippendale 1250 & Brennan*, 11 Apr 1975 (CANB, NSW). North Western Slopes: 6.8 km W of

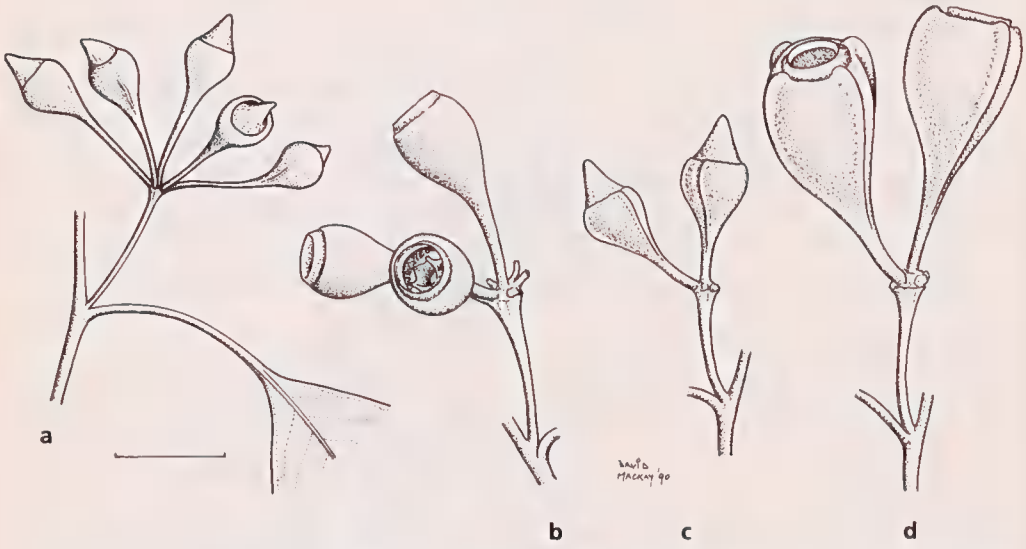

Figure 12. *E. caleyi* subsp. *caleyi*. **a**, buds. **b**, fruits (from *Linton 1*). *E. caleyi* subsp. *ovendenii*. **c**, buds. **d**, fruits (from *Ovenden AGF 1322*). Scale bar = 1 cm.

Ashford on Graman road, *Coveny 11706 & P. Wilson*, 2 Nov 1983 (NSW); c. 14 km NE of 'Keera' on Copeton Dam road, *K. Wilson 2525*, 22 Aug 1979 (NSW); Bundarra, *Julius 1*, June 1917 (NSW); Linton, Barraba district, *de Beuzeville 8*, 23 Jan 1913 (NSW); Attunga State Forest, *Taylor 7*, 3 Feb 1921 (NSW); Ogunbil, *Blakely*, Apr 1927 (NSW). Central Western Slopes: Baerami, *Cambage 2670*, 13 May 1911 (NSW); W of Wollar, *Johnson & Constable*, 9 Aug 1950 (NSW 14513); 0.5 miles [0.8 km] from Murrumbo towards Rylstone, *Brooker 4659*, 15 Nov 1974 (CANB, NSW). North Western Plains: Bebo State Forest, *Bosman 5*, Sep 1977 (NSW). QUEENSLAND: 'Logancrail', Gore, *Bissett S 771*, 7 Apr 1951 (BRI, NSW); Ballandean, *White 9394*, 14 Oct 1953 (BRI, NSW); Inglewood, *White 6112*, Nov 1922 (BRI, NSW).

12B. Eucalyptus caleyi *Maiden* subsp. **ovendenii** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecies *caleyi* fructibus distincte quadrangularibus et saepe majoribus differt.

TYPE: NEW SOUTH WALES: Northern Tablelands: 25 km NW of Torrington, *P. Ovenden AGF 1322*, 30 July 1979 (holo NSW).

Distinguished by the distinctly quadrangular and often larger fruits (9–12 mm long) (Figure 12).

This taxon occurs within the range of subsp. *caleyi*, but occupies the crests of broad high ridges in a replacement pattern. Subsp. *caleyi* occurs on lower slopes in the same general area, and intergradation occurs in intervening areas. Subsp. *ovendenii* is known only from a limited area west of Tenterfield (Figure 13).

This subspecies occurs on shallow soils in open grassy woodlands with *E. melliodora* and *E. dealbata*.

CONSERVATION STATUS: 2V–.This taxon occurs over a limited area, and all known stands are on privately held property.

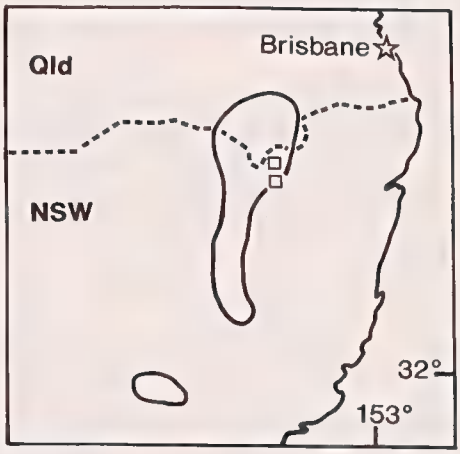

Figure 13. Distribution of *E. caley* subsp. *caleyi* (solid outline) and subsp. *ovendenii* (□).

The epithet honours Peter Ovenden, formerly of the Tenterfield District Forestry Office, an astute observer of the district's flora, who brought this taxon to our attention.

SPECIMENS EXAMINED: NEW SOUTH WALES: North Western Slopes: 'Moorabinda' station, *Hill 817, 818, 822, Johnson & Ovenden*, 10 Apr 1984 (NSW).

13. Eucalyptus tricarpa *(L. Johnson) L. Johnson & K. Hill*, **stat. nov.**

BASIONYM: *Eucalyptus sideroxylon* A. Cunn. ex Woolls subsp. *tricarpa* L. Johnson, Contr. New South Wales Natl. Herb. 3(3): 122 (1962).

TYPE CITATION: 'Holotype: Tilba Tilba to Wallaga Lake, N.S.W., *L.A.S. Johnson* 20.11.1950 (NSW 54090), flowering and fruiting.'

TYPE: holo NSW.

Distinguished from *E. sideroxylon* by the uniformly 3-flowered umbellasters.

DISTRIBUTION: This species has two disjunct areas of occurrence, the first mainly coastal in southern N.S.W. and eastern Victoria, from the Araluen district south, and west to the Bairnsdale district. The second is in central western Victoria, from St Arnaud south to Anglesea, east to Bendigo and east of Melbourne (Figure 14). The range does not approach that of *E. sideroxylon*, which is mainly an inland species in N.S.W. and southern Queensland, with very limited distribution in northern central Victoria and also restricted distribution in coastal regions of N.S.W.

ECOLOGY: usually in open forest or closed woodland on shallow soils on sloping country.

The differences between this taxon and *E. sideroxylon* have been documented by Bramwells & Whiffin (1984).

Hybrids are recorded with *E. bosistoana* F. Muell.

CONSERVATION STATUS: not considered to be at risk.

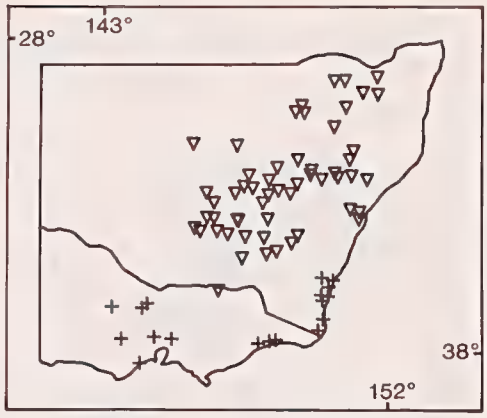

Figure 14. Distribution of *E. tricarpa* (+) and *E. sideroxylon* (▽), excluding Qld occurrences of the latter.

SELECTED SPECIMENS (from 38 examined): NEW SOUTH WALES: South Coast: 14.8 miles [24 km] from North Araluen towards Moruya, *Brooker 4943*, 16 Sep 1975 (NSW, CANB); Bermagui turnoff, Princes Hwy, *Turner 398*, 2 Jul 1980 (NSW, CANB); Wallaga Lake, *Brooker 3305*, 29 Oct 1971 (NSW, CANB); 4 miles [6.4 km] N of Merimbula, *Pullen 4040*, 17 Mar 1964 (NSW, CANB); 0.5 miles [0.8 km] W of Jane Spiers Beach, Nadgee Nature Reserve, *Pickard 1146*, 3 Jun 1970 (NSW). VICTORIA: 3.7 km E of St Arnaud, *Hill 1628, Johnson & Wilson*, 6 Mar 1986 (NSW); 1.5 km from Anglesea towards Aireys Inlet, *Brooker 5951*, 22 Aug 1978 (CANB, MEL, NSW); 5.3 km S of Marlborough turnoff at Kangaroo Flat, *Hill 1615, Johnson & Wilson*, 5 Mar 1986 (NSW, CANB, MEL, PERTH); Reeve Road, W of Orbost, *Brooker 6817*, 16 Jan 1980 (CANB, MEL, NSW); Bruthen to Double Bridges, *Cambage 3675*, 16 Jan 1913 (NSW).

14. Eucalyptus prominula *L. Johnson & K. Hill*, sp. nov.

Species *E. tindaliae* similis sed combinatione characterum sequentium distinguitur: folia adulta majora, crassiora, viridiora; alabastra majora, angularia; pedunculi longiores, crassiores, angulares; hypanthium ad summum tandem incurvum.

TYPE: NEW SOUTH WALES: Central Coast: 1 mile [1.6 km] N of Bucketty on Old North Road, *L.A.S. Johnson*, 12 May 1960 (holo NSW).

Tree to 20 m. *Bark* persistent to smallest branches, grey, long-fibrous ('stringybark'). *Juvenile leaves* opposite or disjunct, ovate, acute, basally rounded or cordate, with moderately dense 'stellate hairs' on all surfaces, to 6 cm long, 3 cm wide; petioles 1–3 mm long. *Adult leaves* disjunct, glabrous, coriaceous, lanceolate to broad lanceolate, oblique, falcate, acuminate or apiculate, glossy green with a bluish sheen, 7–15 cm long, 1.4–3.2 cm wide; petioles 13–20 mm long; lateral veins indistinct, well-spaced, at 20–30° to midrib; intramarginal vein indistinct, 1–2 mm from margin. *Umbellasters* axillary, more than 7-flowered; peduncles angular, thick, 7–14 mm long; pedicels angular, 2–4 mm long. *Mature buds* distinctly angular, 7–9 mm long, 3–4 mm diam.; calyptra conical, acute, angular, slightly longer than hypanthium. *Fruits* globular, flattened, 4-locular, often with 2 or 3 low ridges, 6–7 mm long, 7–9 mm diam.; hypanthium globular, constricted above; calyptra scar a distinct narrow groove; disc flat to slightly raised, ultimately incurved, 1.5–2 mm wide; valves enclosed, ultimate fine tips usually exserted. *Seeds* dark brownish black, satiny, reniform, to 2 mm long; chaff similar, dull, brown, smaller.

E. prominula differs from *E. tindaliae* Blakely in the larger, angular buds (4–6 mm long, 3–4 mm diam. in the latter) with longer pedicels (buds sessile or pedicels to 2 mm long in the latter), and in the partly exserted valves. Peduncles tend to be longer, thicker, and more strongly angular, and adult leaves tend to be larger and thicker in *E. prominula*.

DISTRIBUTION: NEW SOUTH WALES: North-western Central Coast District, inland sandstone country, from the Hawkesbury River north to Broke (Figure 15).

ECOLOGY: Locally common but usually only over limited areas, on dry sandstone or shaley sandstone ridges, often in association with *E. gummifera* (Sol. ex Gaertn.) Hochr., *E. eximia* Schauer, *E. piperita* Smith and *E. racemosa* Cav.

The epithet is from the Latin *prominulus*, projecting a little, referring to the partially exserted valves of this species.

CONSERVATION STATUS: 2RC. This species occurs on country unlikely to be threatened by development, and several populations occur in the Yengo National Park.

SELECTED SPECIMENS (from 14 examined): NEW SOUTH WALES: North Coast: Pokolbin State Forest, *Bailey*, 22 Jun 1961 (NSW). Central Coast: 5.5 km due W of Paynes Crossing bridge, *Hill 2785 & Stanberg*, 3 May 1988 (NSW, BRI, PERTH); 3.3 km S of Fernances Crossing on Broke – Bucketty road, *Hill 1263 & Johnson*, 9 Sep 1985 (NSW, CANB, MEL); 5 miles [8 km] NE of Wisemans Ferry, *Johnson*, 2 Aug 1968 (NSW).

15. Eucalyptus tenella *L. Johnson & K. Hill*, **sp. nov.**

Species *E. sparsifoliae* similis sed foliis parvis angustisque et calyptra rotundata differt.

TYPE: NEW SOUTH WALES: Central Tablelands: Capertee, *L.A.S. Johnson*, 30 Sep 1968 (holo NSW).

Tree to 15 m tall, often less. *Bark* persistent to smallest branches, grey, long-fibrous ('stringybark'). *Juvenile leaves* opposite or disjunct, linear to narrow-lanceolate, acute, basally rounded or tapered, with 'stellate hairs' on all surfaces, to 3 cm long, 0.7 cm wide; petioles 0–2 mm long. *Adult leaves* disjunct, glabrous, coriaceous, linear to narrow-lanceolate, falcate, acuminate, glossy green, 5–9 cm long, 0.6–1.3 cm wide; petioles 5–8 mm long; lateral veins indistinct, well-spaced, at 20–30° to midrib; intramarginal vein indistinct, to 1 mm from margin. *Umbellasters* axillary, more than 7-flowered; peduncles angular, 3–8 mm long; pedicels 0–1 mm long. *Mature buds* ovoid, 4–5 mm long, 1.5–2 mm diam.; calyptra hemispherical to convex-conical, obtuse,

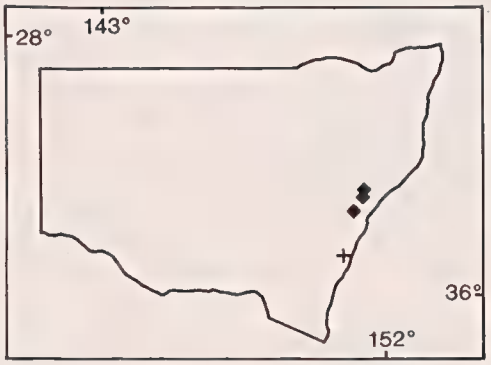

Figure 15. Distribution of *E. prominula* (◆) and *E. imitans* (+).

shorter than hypanthium. *Fruits* globular, flattened, 3–4-locular, 4–5 mm long, 5–7 mm diam.; hypanthium globular, constricted above; calyptra scar a distinct narrow groove; disc flat to slightly raised, ultimately incurved, 0.5-1.5 mm wide; valves enclosed or rim-level. *Seeds* dark brownish black, reniform, to 1 mm long; chaff similar, dull, brown, smaller. Figure 16.

Distinguished from *E. sparsifolia* Blakely by the small, narrow leaves, the rounded calyptra and the smaller fruits (to 8 mm long, 8 mm diam. in the latter). Adult leaves are narrow-lanceolate to lanceolate and 8–12 cm long by 10–25 mm wide in *E. sparsifolia*, and the calyptra is acute.

Distribution: Central Tablelands of New South Wales, from near Rylstone to the Megalong Valley (Figure 17).

Ecology: A component of dry sclerophyll woodlands on relatively infertile, sandy soils, usually on flat to gently rolling country with species such as *E. mannifera* Mudie and *E. rossii* R. Baker & H.G. Smith or *E. sclerophylla* (Blakely) L. Johnson & Blaxell.

Intergradation occurs with *E. sparsifolia* where the ranges meet.

The epithet is from the Latin *tenellus*, somewhat delicate, referring to the small leaves, buds and fruits.

Conservation status: not considered to be at risk.

Selected specimens (from 21 examined): New South Wales: Central Tablelands: 1.2 km S of Kandos, *J.D. Briggs 229 & Pryor*, 27 Feb 1979 (CANB, NSW); head of Benjang Creek, ENE of Rylstone, *Catford*, Apr 1965 (NSW); Ilford, *Brooker 4666*, 16 Nov 1974 (CANB, NSW); 1 km S of Ilford, *Johnson 7581*, 27 Feb 1973 (NSW); 2.8 miles [4.5 km] S then 3 miles [4.8 km] E by road from Hartley Vale, Kanimbla Valley, *Johnson & McKern*, 26 Sep 1966 (NSW); Pulpit Hill Ck to Chaplowe Ck, Megalong Valley, *Johnson*, 12 Aug 1953 (NSW 24966).

16. Eucalyptus ralla *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. sparsifolia* foliis adultis linearibus vel anguste lanceolatis, et ab *E. tenella* foliis valde longioribus, distinguitur.

Type: New South Wales: South Coast: 1 mile [1.6 km] N of Danjera Creek on Nowra – Yalwal road, *L. Johnson, D. Blaxell & B.G. Briggs 3139*, 18 Dec 1969 (holo NSW; iso CANB, MEL).

Tree to 15 m tall. *Bark* persistent to smallest branches, grey, long-fibrous ('stringybark'). *Juvenile leaves* opposite or disjunct, linear to lanceolate, acute, basally rounded or cordate, with 'stellate hairs' on all surfaces, to 5 cm long, 1.5 cm wide; petioles 0–2 mm long. *Adult leaves* disjunct, glabrous, coriaceous, linear to narrow-lanceolate, falcate, acuminate, glossy green, 6–15 cm long, 0.6–1.8 cm wide; petioles 6–11 mm long; lateral veins indistinct, well-spaced, at 20–30° to midrib; intramarginal vein indistinct, to 1 mm from margin. *Umbellasters* axillary, more than 7-flowered; peduncles angular, 4–9 mm long; pedicels angular, 1–2 mm long. *Mature buds* fusiform, 4–6 mm long, 1.5–2 mm diam.; calyptra conical, acute, about as long as hypanthium. *Fruits* globular, flattened, 3–4-locular, 4–5 mm long, 5–7 mm diam.; hypanthium globular, constricted above; calyptra scar a distinct narrow groove; disc flat to slightly raised, ultimately incurved, 0.5–1.5 mm wide; valves deeply enclosed. *Seeds* dark brownish black, reniform, to 1 mm long; chaff similar, dull, brown, smaller. Figure 18.

Distinguished from *E. sparsifolia* Blakely by the linear to narrow-lanceolate adult leaves, and smaller fruits (to 8 mm long, 8 mm diam. in the latter). The leaves are much longer than those of *E. tenella*, and buds are more pointed.

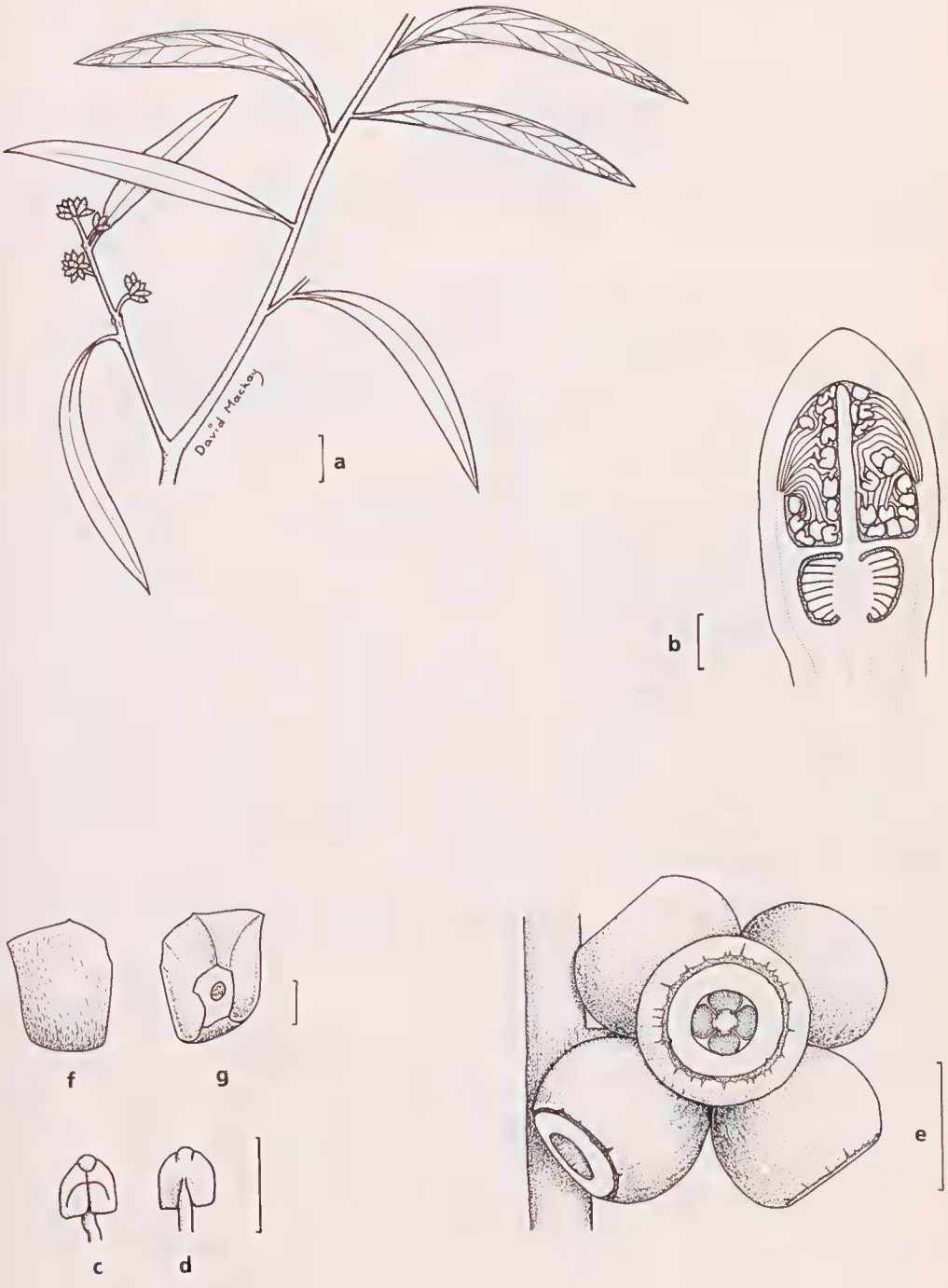

Figure 16. *E. tenella*. **a**, adult leaves and buds. **b**, median section of bud. **c**, **d**, anther. **e**, fruit. **f**, **g**, seed (all from *Johnson 7581*). Scale bar: a = 1 cm; b, c, d, f, g = 0.5 mm; e = 5 mm.

DISTRIBUTION: Upper Nattai River to Yalwal district (Figure 17).

ECOLOGY: Usually locally frequent in dry sclerophyll woodland on steep, rocky sandstone slopes.

The epithet is from the Latin *rallus*, slender, referring to the narrow adult and juvenile leaves.

CONSERVATION STATUS: not considered to be at risk, but further collecting is necessary to ascertain its distribution in more detail.

SELECTED SPECIMENS (from 9 examined): NEW SOUTH WALES: Central Tablelands: Nattai River, *Olsen 2163, 2164*, 29 Jun 1974 (NSW). South Coast: Yalwal, *Blaxell 1602, 1603 & Johnson*, 26 May 1978 (NSW, CANB, K, MEL).

17. Eucalyptus imitans *L. Johnson & K. Hill*, **sp. nov.**

Similis *E. oblongae* sed distinguitur: alabastra fructusque majores, calyptra brevior rotundataque, et folia adulta juveniliaque grossiora.

TYPE: NEW SOUTH WALES: Central Coast: 20.3 km from Kangaroo Valley towards Tallowa Dam, *K. Hill 3620 & R. Makinson*, 7 Nov 1989 (holo NSW; iso BRI, CANB, MEL).

Tree to 10 m tall. *Bark* persistent to smallest branches, grey, long-fibrous ('stringybark'). *Juvenile leaves* disjunct, ovate, rounded or apiculate, basally rounded, with 'stellate hairs' on all surfaces, to 5 cm long, 2.5 cm wide; petioles 3–5 mm long. *Adult leaves* disjunct, glabrous, coriaceous, broad lanceolate to ovate, oblique, rounded or apiculate, glossy green, 5–13 cm long, 1.5–3.8 cm wide; petioles 7–12 n m long; lateral veins distinct, well-spaced, at 30–40° to midrib; intramarginal vein distinct, 1–2 mm from margin. *Umbellasters* axillary, more than 7-flowered; peduncles 6–12 mm long; pedicels 0–3 mm long. *Mature buds* ovoid, 5–7 mm long, 2.5–3.5 mm diam.; calyptra hemispherical or convex-conical, often apiculate, slightly longer than hypanthium. *Fruits* globular, flattened, 4-locular, 5–7 mm long, 7–9 mm diam.; hypanthium globular, constricted above; calyptra scar a distinct narrow groove around hypanthium; disc flat to slightly raised, ultimately incurved, 1.5–2.5 mm wide; valves enclosed, ultimate fine tips sometimes exserted. *Seeds* dark brownish black, reniform, to 1.5 mm long; chaff similar, dull, brown, smaller. Figure 19.

Distinguished from *E. oblonga* DC. by the larger buds and fruits (to 7 mm diam. in the latter), the shorter and more rounded calyptra, and the generally coarser adult and juvenile foliage.

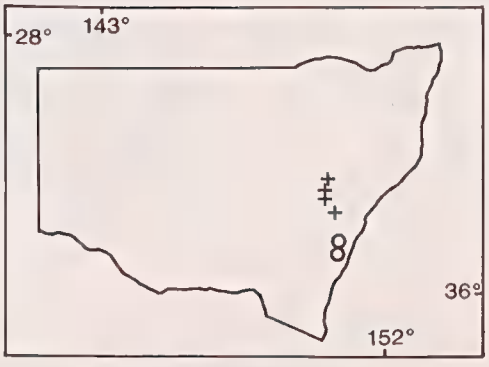

Figure 17. Distribution of *E. tenella* (+) and *E. ralla* (○).

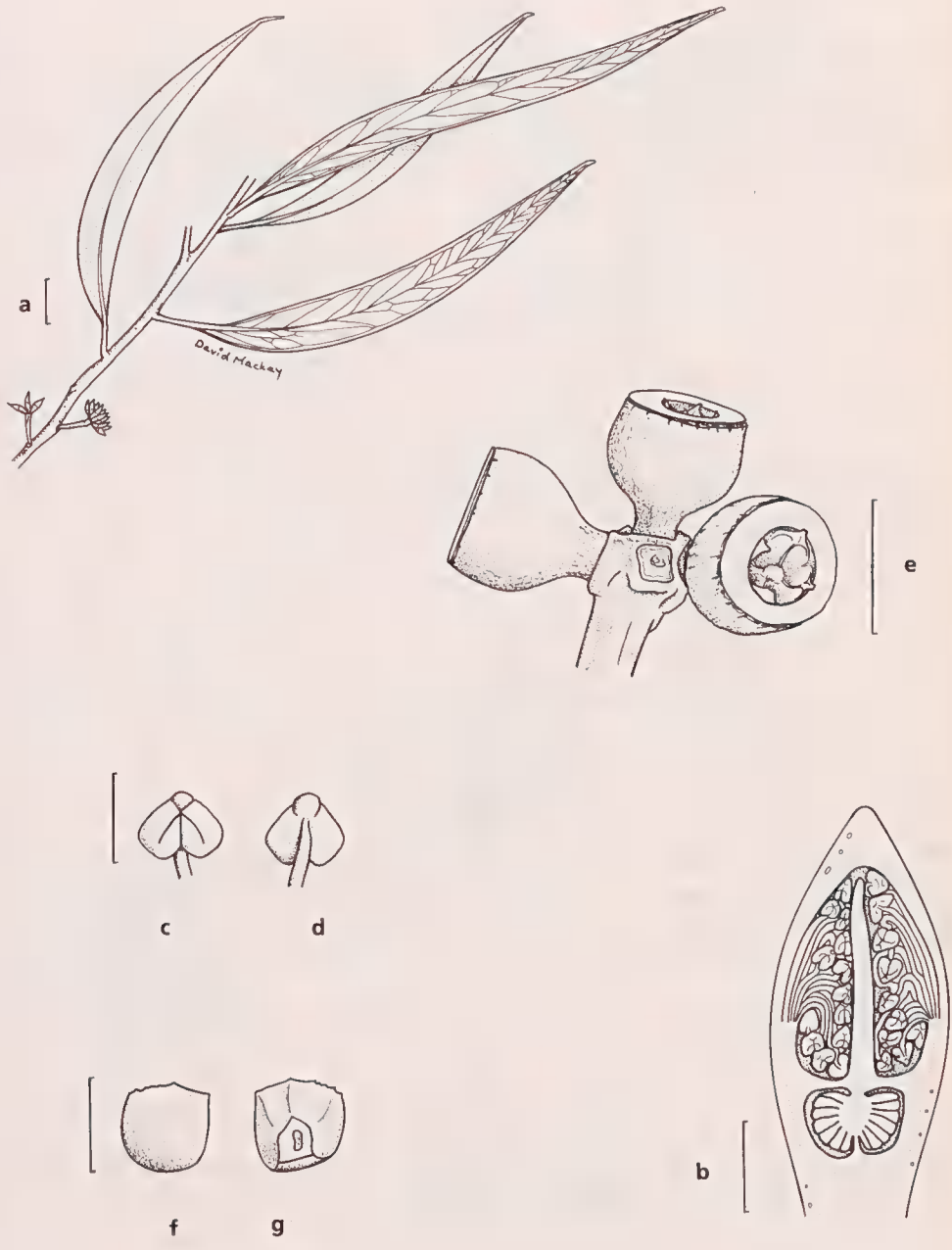

Figure 18. *E. ralla*. **a**, adult leaves and buds. **b**, median section of bud. **c**, **d**, anther. **e**, fruit. **f**, **g**, seed (all from *Johnson, Blaxell & Briggs 3139*). Scale bar: a = 1 cm; b, c, d, f, g = 0.5 mm; e = 5 mm.

Figure 19. *E. imitans*. **a**, adult leaves and buds. **b**, juvenile leaves. **c**, median section of bud. **d**, **e**, anther. **f**, fruit. **g**, **h**, seed (all from *Johnson, Blaxell & Briggs 3134*). Scale bar: a, b, f = 1 cm; c, = 5 mm; d, e, g, h = 0.5 mm; e = 5 mm.

Distribution: Tallong to Nerriga, east to near Nowra (Figure 15).

Ecology: Locally abundant in low dry sclerophyll woodland on sandstone plateau country.

The epithet is from the Latin *imitans*, imitating, from the resemblance to *E. oblonga*.

Conservation status: not considered to be at risk.

Selected specimens (from 12 examined): New South Wales: Central Tablelands: 17 km ESE of Tallong, *Johnson 8376*, 30 Oct 1977 (NSW). Southern Tablelands: Nerriga, *Walker ANU 1158*, Oct 1983 (CANB, NSW). South Coast: Yalwal Creek fire trail, *Gilmour 5207*, 11 Sep 1985 (CBG, MEL, NSW); 6 miles [9.6 km] W of Nowra on Yalwal road, *Blaxell 1340 & Johnson*, 21 Apr 1974 (NSW); 15 miles [24 km] W of Nowra on Yalwal road, *Johnson, Blaxell & B.G. Briggs 3134*, 18 Dec 1969 (NSW).

18. Eucalyptus spectatrix *L. Johnson & Blaxell*, **sp. nov.**

Affinis *E. dendromorphae* sed combinatione characterum sequentium distinguitur: folia minora venatione minus prominenti et folia juvenilia lanceolata minora. Folia majora quam illa *E. strictae* sunt.

Type: New South Wales: South Coast: 2 km due east of Mumbulla Trig, NE of Bega, *D.F. Blaxell 1761*, 2 May 1979 (holo NSW; iso AD, BRI, CANB, HO, K, MEL, PERTH).

Mallee to 6 m high. *Bark* smooth, grey-brown and cream, shedding in strips. *Juvenile leaves* disjunct, lanceolate, falcate, to 13 cm long, 2 cm wide, venation and oil glands distinct, lateral veins at 20–30° to midrib. *Adult leaves* disjunct, lanceolate, oblique, falcate, attenuate, coriaceous, 7–13 cm long, 1–2 cm wide; petioles flattened, 6–10 mm long; lateral and intramarginal veins indistinct; oil glands large and prominent. *Umbellasters* axillary, 7-flowered; peduncles 2-angled, 1–15 mm long; pedicels terete or vaguely angular, 1–3 mm long. *Mature buds* irregularly pyriform, verrucose, 7–10 mm long, 4–5 mm diam.; calyptra convex, obtuse, less than ¼ as long as hypanthium. *Fruits* urceolate to cup-shaped, usually apically constricted, 4-locular, 8–11 mm long, 8–10 mm diam.; calyptra scar a narrow groove around hypanthium; stemonophore narrow, raised above disc and hypanthium; disc at first sharply depressed, becoming flat, up to 2 mm wide; valves fully enclosed, vertical when opened. *Seeds* grey-brown or brown, reniform, angular, to 2 mm long; chaff similar.

E. spectatrix differs from *E. dendromorpha* (Blakely) L. Johnson & Blaxell in the narrower juvenile leaves (broad-lanceolate in the latter) and the consistent mallee habit. The leaves and fruits are larger than in the related mallee species *E. stricta* Sieber ex Sprengel (which has adult leaves 6–10 cm long, 6–10 mm wide, and fruit 7–10 mm long, 6–8 mm diam.).

Distribution: New South Wales: Known from a few mountain tops in the Bega district, southern South Coast (Figure 20).

Ecology: This species occurs in crevices with very little soil on rocky granite hilltops, usually in a scleromorphic shrub community.

The epithet is from the Latin, *spectatrix*, she who observes, referring to the occurrence of this species on prominent, bare hill tops. It is used as a noun, not an adjective.

Conservation status: 2RC. The limited stands of this taxon occur in relatively secure habitats.

Selected specimens (from 16 examined): New South Wales: South Coast: Dr George Mtn, *Hill 1358 & Johnson*, 16 Feb 1986 (NSW), *Brooker 6946*, 19 May 1980 (CANB, NSW); 4 km N of Mumbulla Mtn, *Miller*, 16 Jun 1978 (NSW); 6.6 km E of Bemboka Peak, *Albrecht 2954*, 4 Nov 1986 (MEL, NSW).

19. Eucalyptus laophila *L. Johnson & Blaxell*, **sp. nov.**

Affinis *E. apiculatae* sed foliis longioribus aliquanto glaucolucentibus et fructibus saepe majoribus differt.

TYPE: NEW SOUTH WALES: Central Tablelands: Wolgan Gap, *L. Johnson*, 12 Apr 1953 (holo NSW 27182).

Mallee to 6 m high. *Bark* smooth, grey-brown and cream, shedding in strips. *Juvenile leaves* disjunct, lanceolate, falcate, to 13 cm long, 2 cm wide, venation and oil glands distinct, lateral veins at 20–30° to midrib. *Adult leaves* disjunct, lanceolate, oblique, falcate, attenuate, coriaceous, glossy green, usually with a bluish sheen, 7–13 cm long, 1.0–2.0 cm wide; petioles flattened, 6–10 mm long; lateral and intramarginal veins indistinct; oil glands large and prominent. *Umbellasters* axillary, 7-flowered; peduncles 2-angled, 1–15 mm long; pedicels terete or vaguely angular, 1–3 mm long. *Mature buds* clavate to pyriform, verrucose, 7–10 mm long, 4–5 mm diam.; calyptra convex, obtuse, apiculate, less than ¼ as long as hypanthium. *Fruits* urceolate to cup-shaped, usually apically constricted, 4-locular, 8–11 mm long, 8–10 mm diam.; calyptra scar a narrow groove around hypanthium; stemonophore narrow, raised above disc and hypanthium; disc at first sharply depressed, becoming flat, up to 2 mm wide; valves fully enclosed, vertical when opened. *Seeds* grey-brown or brown, reniform, angular, to 2 mm long; chaff similar. Figure 21.

Distinguished from *E. apiculata* by the bluish sheen in adult foliage, the larger and relatively broader adult leaves (i.e. lower length:breadth ratio) and the larger fruits. The latter two characters show some overlap (*E. apiculata* has adult leaves 5–10 cm long, 5–7 mm wide, and fruit 6–9 mm long, 6–8 mm diam.).

DISTRIBUTION: Mt Coricudgy district to south of Newnes (Figure 20). It is disjunct from *E. apiculata*, which occurs from the Springwood district south to near Berrima and near Mt Keira.

ECOLOGY: Locally abundant in scleromorphic mallee heath on shallow sandy soils. This taxon characteristically occurs around the distinctive 'beehive' or 'pagoda' formations of weathered sandstone of the Triassic Narrabeen Group.

Hybrids and intergrades occur with *E. stricta* to a limited extent around the Newnes Plateau. The related *E. apiculata* also hybridises and intergrades with *E. stricta* in the northern and eastern parts of its range (Springwood and Mt Keira), but does not meet *E. laophila*.

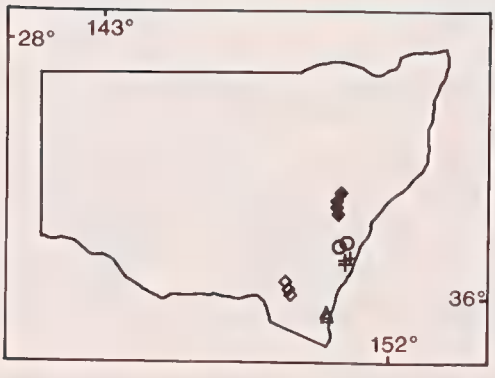

Figure 20. Distribution of *E. spectatrix* (△), *E. laophila* (◆), *E. apiculata* (○), *E. langleyi* (+) and *E. lacrimans* (◇).

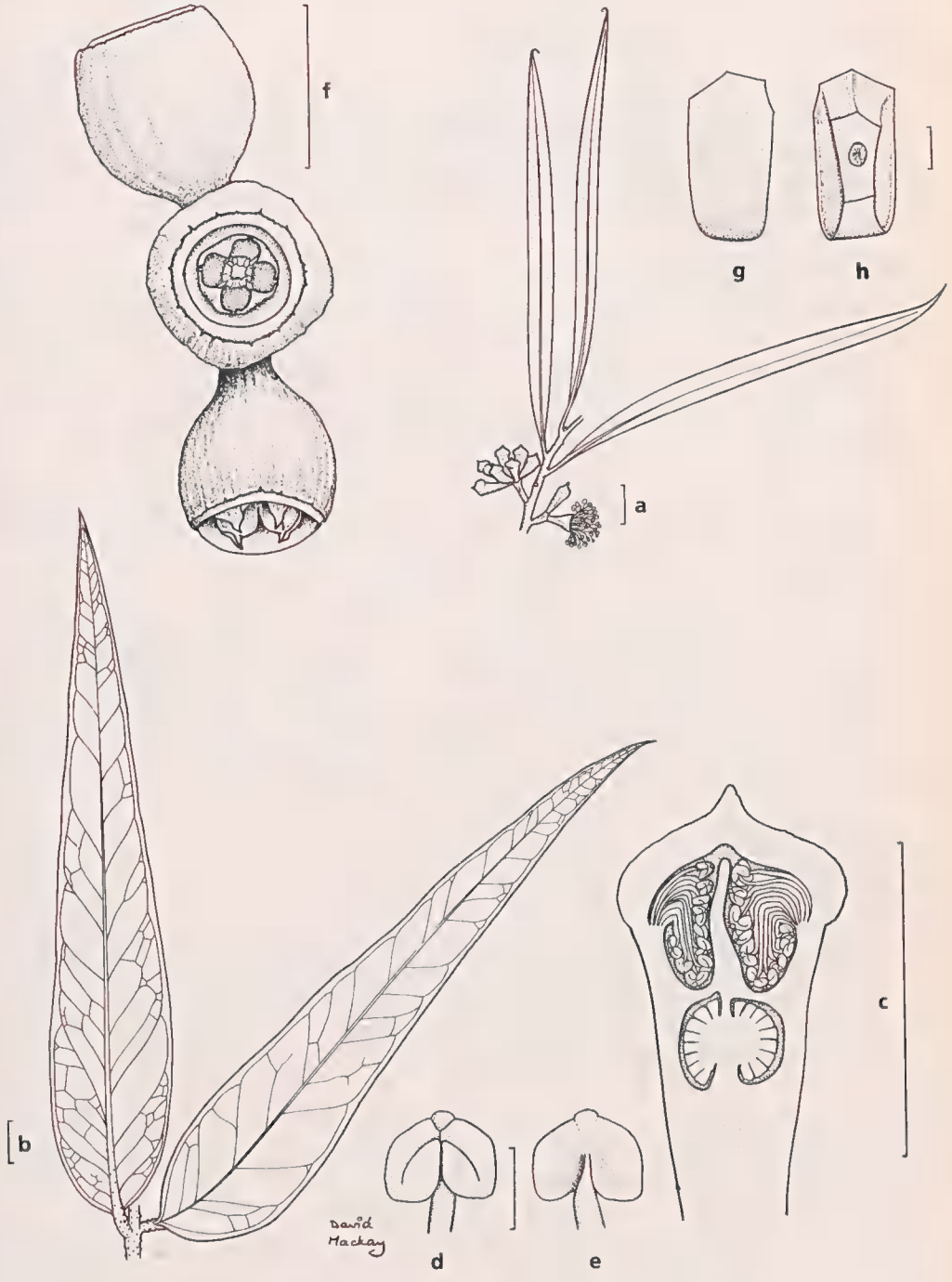

Figure 21. *E. laophila*. **a**, adult leaves, buds and flowers. **b**, juvenile leaves. **c**, median section of bud. **d**, **e**, anther. **f**, fruit. **g**, **h**, seed (a, b, c, d, e from *Crisp 1277*, f, g, h from *McGillivray & Rodd R140*). Scale bar: a, b, f = 1 cm; c = 5 mm; d, e, g, h = 0.5 mm.

The epithet is from the Greek *laas* or *laos*, a stone (not *laos*, people), and *-philos*, loving, from the species' occurrence among rocky outcrops. The stress is on the '-o-' as in other '-ophilus' (but not '-ophyllus') epithets.

CONSERVATION STATUS: not considered to be at risk.

SELECTED SPECIMENS (from 24 examined): NEW SOUTH WALES: Central Tablelands: firetrail between Kekeelbon and Coricudgy Mtns, *McGillivray 1612*, 13 Feb 1966 (NSW); Currant Mtn Gap, *Rodd 2591*, 30 Nov 1973 (NSW); Gospers Mtn road, 11 miles [18 km] from turnoff at Red Hill, *McGillivray & Rodd R140*, 26 Apr 1965 (NSW); 1.5 km S of Kandos Weir, *Crisp 1277*, 4 Oct 1975 (CBG, NSW); Glow-worm Tunnel area, 35 km NNE of Lithgow, *Hind 852*, 29 Aug 1976 (NSW); 37 km N of Clarence on Newnes Tunnel road, *Coveny 3565*, 6 Apr 1971 (NSW).

20. Eucalyptus obstans *L. Johnson & K. Hill*, **sp. nov.**

Frutex vel arbuscula multicaulis. Cortex laevis. Folia juvenilia late lanceolata vel ovata. Folia adulta late lanceolata, 6–10 cm longa, 15–25 mm lata, petiolis 8–15 mm longis. Umbellastrae in axillis foliorum evolutorum, plerumque 7-florae, pedunculis 7–15 mm longis, pedicellis 1–5 mm longis. Alabastra clavata vel pyriformia, 7–9 mm longa, 5–7 mm diametro; calyptra paulo brevior quam hypanthium, verruculosa, plerumque apiculata. Fructus urceolati ad globulares, 10–13 mm longi, 8–11 mm diametro.

TYPE: NEW SOUTH WALES: Central Coast: ½ mile [0.8 km] NW of Governor Game Lookout, Royal National Park, *J. O'Hara & R. Coveny 3560*, 31 Mar 1971 (holo NSW; iso CANB, K).

[*E. obtusiflora* auct. non DC. (1828), Bentham (1867), et auct. plur.]

Maiden (1907) made the combination *E. virgata* Sieber ex Sprengel var. *obtusiflora* (DC.) Maiden based on de Candolle's name, understanding that de Candolle's type represented the eastern Australian species that we are naming *E. obstans*. All of Maiden's cited material is of this eastern taxon. De Candolle also apparently confused the taxa, his original type representing a Western Australian species (*E. obtusiflora*, until now known by its later synonym *E. dongarraensis* Maiden & Blakely). Other material he later cited represents *E. obstans* (*Sieber 473*, cited in Mém. Myrt., 1842).

[*E. obtusifolia* sphalm., G. Don (1832)]

[*E. rigida* Sieber ex Benth., Fl. Austral. 3: 205 (1867), in syn., nom. nud.; R. Br. ex Maiden, Crit. Revis. Eucalyptus 1: 273 (1907), in syn., nom. nud.; non Hoffsgg. (1826)]

Mallee to 4 m tall. *Bark* smooth. *Juvenile leaves* broad-lanceolate to ovate. *Adult leaves* broad-lanceolate, 6–10 cm long, 15–25 mm wide; petioles 8–15 mm long. *Inflorescences* simple, axillary, umbellasters usually 7-flowered; peduncles 7–15 mm long; pedicels 1–5 mm long. *Buds* clavate to pyriform, 7–9 mm long, 5–7 mm diam.; calyptra slightly shorter than hypanthium, finely verrucose, usually apiculate. *Fruits* urceolate to globular, 10–13 mm long, 8–11 mm diam.

Nearest to *E. stricta*, from which it differs in the broad-lanceolate adult and juvenile leaves (both lanceolate or narrower in *E. stricta*), and the larger buds and fruits (buds to 4 mm diam., fruit to 8 mm diam. in *E. stricta*). The related *E. dendromorpha* differs in the tree habit and the smaller buds (to 7 mm long, 4 mm diam.).

Intergrading populations occur with *E. dendromorpha* (Blakely) L. Johnson & Blaxell and *E. stricta* Sieber ex Sprengel. Hybrids are recorded with *E. luehmanniana* F. Muell. (named as *E. virgata* Sieber ex Sprengel and *E. sieberiana* F. Muell.) and *E. sieberi* L. Johnson. Hybrids are also recorded between *E. obstans* – *E. stricta* intergrades and *E. triflora* (Maiden) Blakely.

The epithet is from the Latin *obstans*, hindering or obstructing, referring to the thick scrubs formed by the species, and is chosen for mnemonic reasons to continue the association with 'ob'.

CONSERVATION STATUS: not considered to be at risk, but now very scarce in the Port Jackson district.

SELECTED SPECIMENS (from 120 examined): NEW SOUTH WALES: Central Coast: 1 mile [1.6 km] NW of Berowra railway station, *Shiress*, 17 Aug 1919 (NSW 26841); Manly, *Boorman*, Nov 1917 (NSW 26944); Bondi sandhills, *Blakely*, 25 Apr 1917 (NSW 26951); La Perouse Road, Botany, *Camfield*, 4 Dec 1899 (NSW 26840); Karloo Pool to Uloola Falls, Royal National Park, *Johnson*, 10 Sep 1950 (NSW 26973); below Stanwell Tops, *Pearson*, 14 May 1981 (NSW). South Coast: Myall Creek Plateau, N of Nerriga, *Whaite 3523*, 28 Jul 1973 (NSW); Rotary Lookout, on Porters Creek Dam road, NW of Milton, *Lowe 299, 300*, 21 Nov 1977 (NSW); 1 3/4 miles [2.5 km] SSE of police station, Jervis Bay, *Hall FRI 20130*, 17 Aug 1971 (CANB, NSW). Central Tablelands: Barren Grounds Nature Reserve, *Coveny 11637*, 25 Sep 1983 (NSW). Southern Tablelands: 2 km N of Pigeon House Mountain, *Lowe 298*, 21 Nov 1977 (NSW).

21. Eucalyptus langleyi *L. Johnson & Blaxell*, **sp. nov.**

Affinis *E. burgessianae* sed combinatione characterum sequentium distinguitur: folia juvenilia late lanceolata vel ovata, folia adulta alabastra fructusque omnes majora, et ramuli distincte alati.

TYPE: NEW SOUTH WALES: South Coast: 1 km along Christmas Bush firetrail, off Nowra – Yalwal road, *D.F. Blaxell 1244 & D.H. Benson*, 6 Feb 1974 (holo NSW).

Mallee to 5 m high. *Bark* smooth, brown, shedding in long ribbons. *Young shoots* prominently 4-winged. Juvenile leaves glossy green, broad-lanceolate to ovate. *Adult leaves* disjunct, lanceolate, acuminate, sometimes oblique, coriaceous, glossy green, 8–18 cm long, 1.8–4.0 cm wide; petioles 8–18 mm long, winged, wings decurrent with wings on twigs; lateral veins obscure, anastomosing, at 10–20° to midrib; intramarginal vein obscure, leaf margin prominently thickened. *Umbellasters* axillary, 7-flowered; peduncles broadly winged, 8–12 mm long, to 7 mm wide apically; pedicels 0–2 mm long, angular. Mature buds irregularly pyriform, rugose, 11–14 mm long, 4–6 mm diam.; calyptra less than $\frac{1}{4}$ as long as hypanthium, hemispherical, very broadly obtuse. *Stamens* all fertile; filaments inflexed into hypanthium in bud; anthers dorsifixed, versatile, reniform, dehiscing through confluent slits. *Fruits* cup-shaped, 3- or 4-locular, sometimes apically constricted, 8–10 mm long, 8–10 mm in diameter, sometimes with 1–3 vertical ridges; calyptra scar a narrow groove around hypanthium, stemonophore 0.5–1 mm wide, flat, ultimately depressed to meet disc; disc enclosed, flat, 1–1.5 mm wide; valves enclosed, tips often exserted. *Seeds* dull, grey-brown, angular, reniform, to 2.5 mm long; chaff similar, smaller. Figure 22.

E. langleyi differs from *E. burgessiana* L. Johnson & Blaxell in the ovate juvenile leaves, the broader adult leaves (less than 25 mm wide in the latter), larger buds (7–10 mm long, 3–4 mm wide in the latter), and the distinctly winged shoots.

DISTRIBUTION: NEW SOUTH WALES: Northern South Coast, immediately inland from Nowra (Figure 20).

ECOLOGY: Locally common on shallow, poorly drained soil over sandstone or associated with laterite, on plateaux in highly dissected areas, often in heath patches surrounded by woodland of *E. gummifera* (Sol. ex Gaert.) Hochr., *E. consideniana* Maiden and a 'Scribbly Gum' under study.

Early collectors confused this species with *E. luehmanniana* F. Muell. because of the large leaves, buds and fruit and the winged stems. The morphology of the juvenile

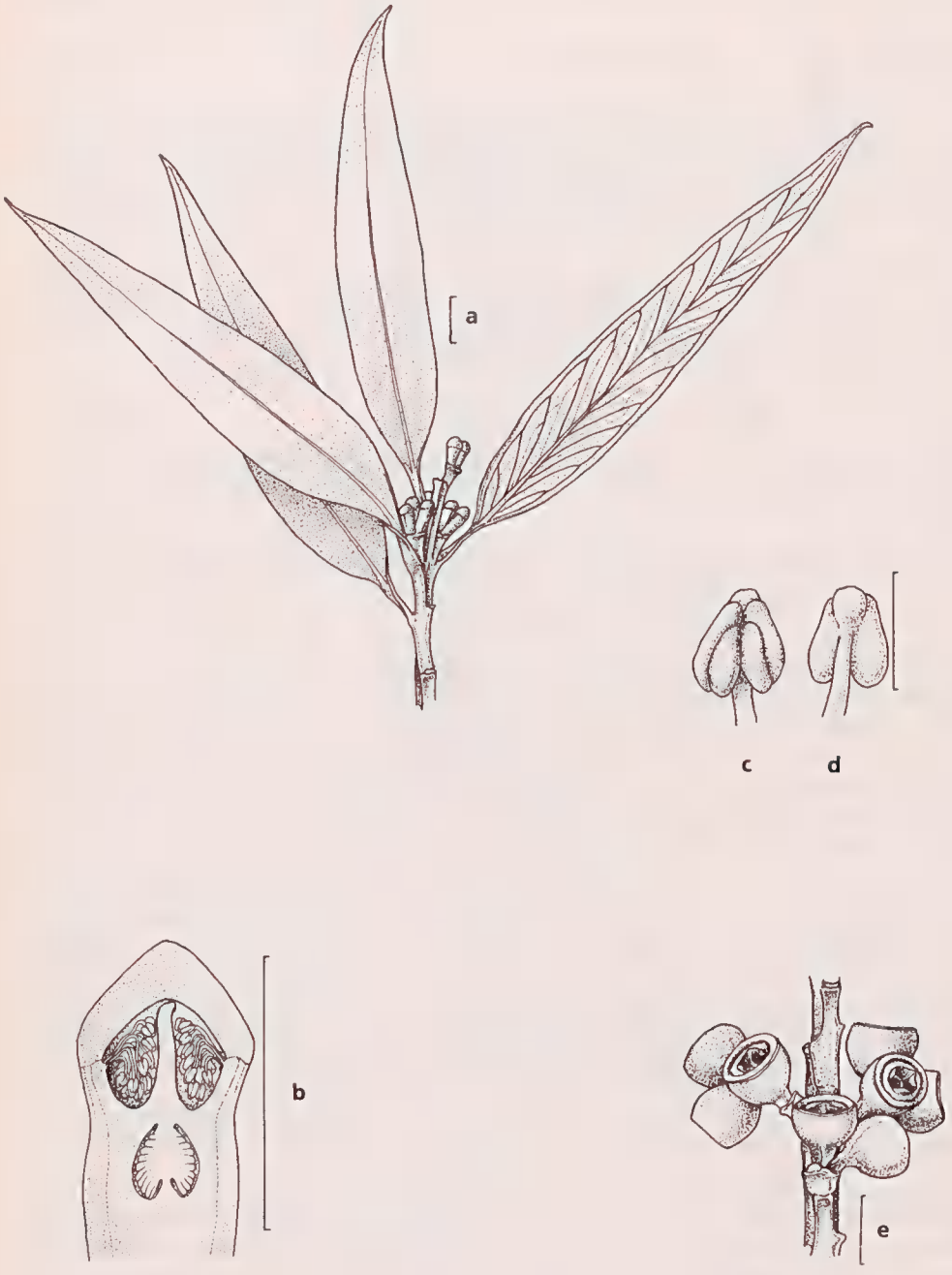

Figure 22. *E. langleyi*. **a**, adult leaves and buds. **b**, median section of bud. **c**, **d**, anther. **e**, fruit (all from *Blaxell 1244*). Scale bar: a, e = 1 cm; b = 5 mm; c, d = 0.5 mm.

leaves and seeds, however, confirm its place with the 'Green Ash' group, clearly distinct from *E. luehmanniana*. This is also evident from microscopic examination of adult leaf surfaces, which are virtually identical with those of *E. burgessiana*, its apparent sister species.

The specific epithet honours Lawrence Langley, of Robertson, who first drew our attention to this taxon.

Conservation status: 2V. This taxon occurs in small stands in unreserved country. The habitat is unlikely to be threatened by agriculture, but at risk from residential and recreational development.

Selected specimens (from 12 examined): New South Wales: Central Coast: Bomaderry walking track, *Mills 13*, 7 Apr 1985 (NSW). South Coast: 8.5 km N of Nerriga – Tomerong road on Nowra road, *J.D. Briggs 32*, 21 Sep 1977 (CANB, NSW); 10.1 miles [16.2 km] from Princes Hwy at Nowra on Braidwood road, *Hall 9*, 4 Aug 1971 (CANB, NSW); c. 3 miles [5 km] SW of H.M.A.S. Albatross on Nowra–Nerriga road, *Johnson & Blaxell 60a*, 7 Dec 1968 (NSW).

22. Eucalyptus copulans *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. stellulata* habitu minore, foliis juvenilibus adultisque minora angustioraque, disco depresso, et ab *E. moorei* habitu majore, foliis majoribus distantioribus, distinguitur.

Type: New South Wales: Central Tablelands: Wentworth Falls, at head of creek just west of railway station, *L. Johnson & E. Constable*, 24 July 1957 (holo NSW 19267).

Tree to 6 m high. *Bark* smooth, grey. *Juvenile leaves* disjunct, narrow-elliptical, apiculate, to 6.5 cm long, 2.5 cm wide; petioles 2–7 mm long. *Adult leaves* disjunct, lanceolate to oblanceolate, acute, 6–12 cm long, 1.0–1.8 cm wide; petioles 5–10 mm long; venation well-spaced, several subparallel, anastomosing veins arising from base. *Umbellasters* axillary, more than 7-flowered; peduncles terete, 3–8 mm long; pedicels 0–1 mm long. *Mature buds* cylindrical, up to 8 mm long, 2.5 mm in diameter; calyptra conical, acute, as long as hypanthium. *Stamens* all fertile; anthers reniform, dorsifixed, versatile, dehiscing by confluent slits. *Fruits* globular, 3-locular, 4–6 mm long, c. 5 mm diam.; calyptra scar and stemonophore distinct, forming a narrow groove around top of fruit; disc discontinuous with hypanthium, c. 1 mm wide, depressed; valves deeply enclosed. *Seeds* dark brown, dull, reniform, rounded, to 2 mm long; chaff similar, slightly smaller.

Distribution: New South Wales: Wentworth Falls, Central Tablelands.

Ecology: Known from a single population growing in a swampy site near a creek on a sandstone plateau. This population appears to have been completely destroyed in the years following 1957, and the species must be presumed to be extinct. The late Rev. Colin Burgess at one time had it in cultivation at Leura, but his plants perished.

E. copulans is nearest to *E. stellulata* Sieber ex DC., differing in the smaller habit, the narrower juvenile leaves (ovate to orbicular in the latter), the narrower adult leaves (elliptical to broad-lanceolate in the latter), and the depressed disc. The habitats also differ, that of *E. copulans* being similar to the preferred habitat of *E. moorei* Maiden & Cambage. It differs from *E. moorei* in the tree habit, larger, broader leaves and depressed disc. *E. copulans* is intermediate in many characters between *E. moorei* and *E. stellulata*, but formed a uniform population that was geographically distant from the nearest populations of *E. moorei* and *E. stellulata*. It is therefore not simply a hybrid, and in view of its distinct and uniform differences must be regarded as equally removed from both *E. moorei* and *E. stellulata*. Some hybrids of *E. copulans* with nearby stringybarks, probably *E. ligustrina x E. sparsifolia*, were formerly also

present at the site.

The epithet is from the Latin *copulans*, joining, referring to the link between *E. moorei* and *E. stellulata* formed by this species.

CONSERVATION STATUS: X, see above. It is of course conceivable that other occurrences may yet be found in swampy sites on the Blue Mountains plateau.

SPECIMENS EXAMINED: NEW SOUTH WALES: Central Tablelands: Wentworth Falls near railway station, *Camfield*, Mar 1899 (NSW); Wentworth Falls, *Burgess*, July 1951 (NSW).

23. Eucalyptus serpentinicola *L. Johnson & Blaxell*, **sp. nov.**

Ab *E. moorei* foliis juvenilibus adultisque longioribus angustioribusque et foliis adultis ramulisque laxis saepe pendulis distinguitur.

TYPE: NEW SOUTH WALES: North Coast: serpentine hills c. 5 km NW of Curricabark, *L. Johnson 7633 & R. Coveny*, 21 Mar 1973 (holo NSW; iso BRI, CANB, MEL, K).

Mallee to 6 m high, usually less. *Bark* smooth, brown, grey-brown, olive-brown. *Foliage* often lax or pendent. *Juvenile leaves* opposite or disjunct, linear to lanceolate, acute, sessile, to 6 cm long, 7 mm wide. *Adult leaves* disjunct, linear to narrow-lanceolate, acute or acuminate, 4–12 cm long, 4–10 mm wide; petioles 0–7 mm long; venation sub-parallel, obscure. *Umbellasters* axillary, 7-flowered or usually more; peduncles terete, 5–10 mm long. *Pedicels* 0–1 mm long. *Mature buds* cylindrical, c. 7 mm long, c. 2.5 mm diam.; calyptra conical, as long as hypanthium. *Stamens* all fertile; filaments erect then inflexed in bud; anthers reniform, dorsifixed, versatile, dehiscing by confluent slits. *Fruits* globular, 3-locular, 4–5 mm long, 4–5 mm diam.; calyptra scar and stemonophore a narrow groove around hypanthium; disc 0.5 to 1 mm wide, flat or shallowly depressed, discontinuous with hypanthium; valves deeply enclosed. *Seeds* dark brown, dull, angular, reniform, to 1.5 mm long; chaff similar, much smaller. Figure 23.

E. serpentinicola is nearest to *E. moorei*, differing in the longer and relatively narrower adult leaves (to 7 cm long and narrow-lanceolate to lanceolate in the latter) and the lax, somewhat bluish green, often pendulous foliage. The dry habitat is also different from the commonly wet, swampy habitat of *E. moorei*. The related mallee species *E. latiuscula* differs from both in the broader adult and juvenile leaves.

DISTRIBUTION: NEW SOUTH WALES: Coastal ranges of the Curricabark area in the south-western North Coast district (Figure 24).

ECOLOGY: Locally common on skeletal soils over steep serpentinite hills, associated with *Xanthorrhoea glauca* Bedford subsp. *glauca* and *Triodia irritans* R. Br. It was first brought to notice by Mr E.L. Hyem, a grazier near Curricabark, who took a particular interest in the 'serpentine' country.

The epithet is from the Latin *serpentinus*, relating to a serpent, and the suffix *-cola*, '-dweller', referring to the restricted occurrence of the species on serpentinite-derived soils. The epithet is a noun, not an adjective.

CONSERVATION STATUS: 2R. Although not conserved, the habitat of this taxon is relatively secure.

SELECTED SPECIMENS (from 7 examined): NEW SOUTH WALES: North Coast: 4 km direct N of Curricabark, *J.D. Briggs 226 & Pryor*, 21 Feb 1979 (CANB, NSW); Watchimbark Ck, 'Myra', *Blaxell 13, 14 & Coveny*, 21 Sep 1968 (NSW). Northern Tablelands: Bralga Tops, 'Glenrock' Station, *Blaxell 1834 & Johnson*, 24 Mar 1981 (NSW).

Figure 23. *E. serpentinicola*. **a,** adult leaves and buds. **b,** juvenile leaves. **c,** median section of bud. **d, e,** anther. **f,** fruit (from *Blaxell 13 & 14*). Scale bar: a, b, f = 1 cm; c = 5 mm; d, e = 0.5 mm.

24. Eucalyptus lacrimans *L. Johnson & K. Hill*, **sp. nov.**

Inter complexum specierum affinitatis *E. pauciflorae* habitu distincto ramulis lacrimantibus foliis valde separatis distinguitur.

TYPE: NEW SOUTH WALES: Southern Tablelands: 12.6 km N of Rules Point on Long Plain, *K. Hill 740, L. Johnson & L. Pryor*, 27 Apr 1984 (holo NSW; iso BRI, CANB, K, MEL).

Tree to 12 m high. *Bark* smooth, white and grey. *Branchlets* glaucous. *Juvenile leaves* disjunct, broad-lanceolate to ovate, apiculate, to 15 cm long, 7 cm wide; petioles 3–7 mm long. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, acuminate, 7–15 cm long, 0.7–2.0 cm wide; petioles 7–16 mm long; venation well-spaced, several subparallel, anastomosing veins arising from base. *Umbellasters* axillary, 7-flowered; peduncles terete or weakly angular, 4–10 mm long; pedicels 0–3 mm long. *Mature buds* glaucous, clavate, 5–7 mm long, 3–4 mm diam.; calyptra hemispherical or broadly conical, obtuse, slightly shorter than hypanthium. *Stamens* all fertile; anthers reniform, dorsifixed, versatile, dehiscing by confluent slits. *Fruits* cup-shaped or obconic, 3–4-locular, 8–10 mm long, 8–10 mm diam.; calyptra scar and stemonophore distinct, forming a narrow raised band around top of fruit; disc flat, 1–2 mm wide; valves enclosed. *Seeds* brownish black, dull, reniform, rounded, to 2 mm long; chaff similar, slightly smaller and paler. Figure 25.

Distinguished from *E. pauciflora* Sieber ex Sprengel by the strongly glaucous twigs and buds, and from *E. niphophila* Maiden & Blakely by the very pendulous branches with elongated internodes.

DISTRIBUTION: NEW SOUTH WALES: Restricted to the Adaminaby–Kiandra district on the Southern Tablelands (Figure 20).

ECOLOGY: Locally common in small, open copses on broad, flat and usually more or less treeless grassy plains, with *Poa* understorey. Such plains form a mosaic with *E. pauciflora* – *E. rubida* subsp. *rubida* woodlands on higher country in the same area.

Some hybridism with *E. pauciflora* is evident where populations adjoin.

CONSERVATION STATUS: 2R. Substantial populations of this taxon are now reserved.

The epithet is from the Latin *lacrimans*, weeping, in reference to the distinctively pendulous branchlets.

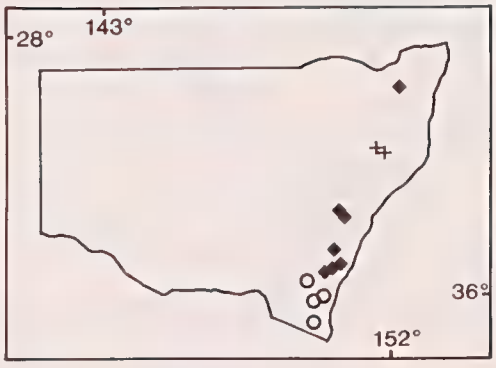

Figure 24. Distribution of *E. serpentinicola* (+), *E. moorei* (◆) and *E. latiuscula* (○).

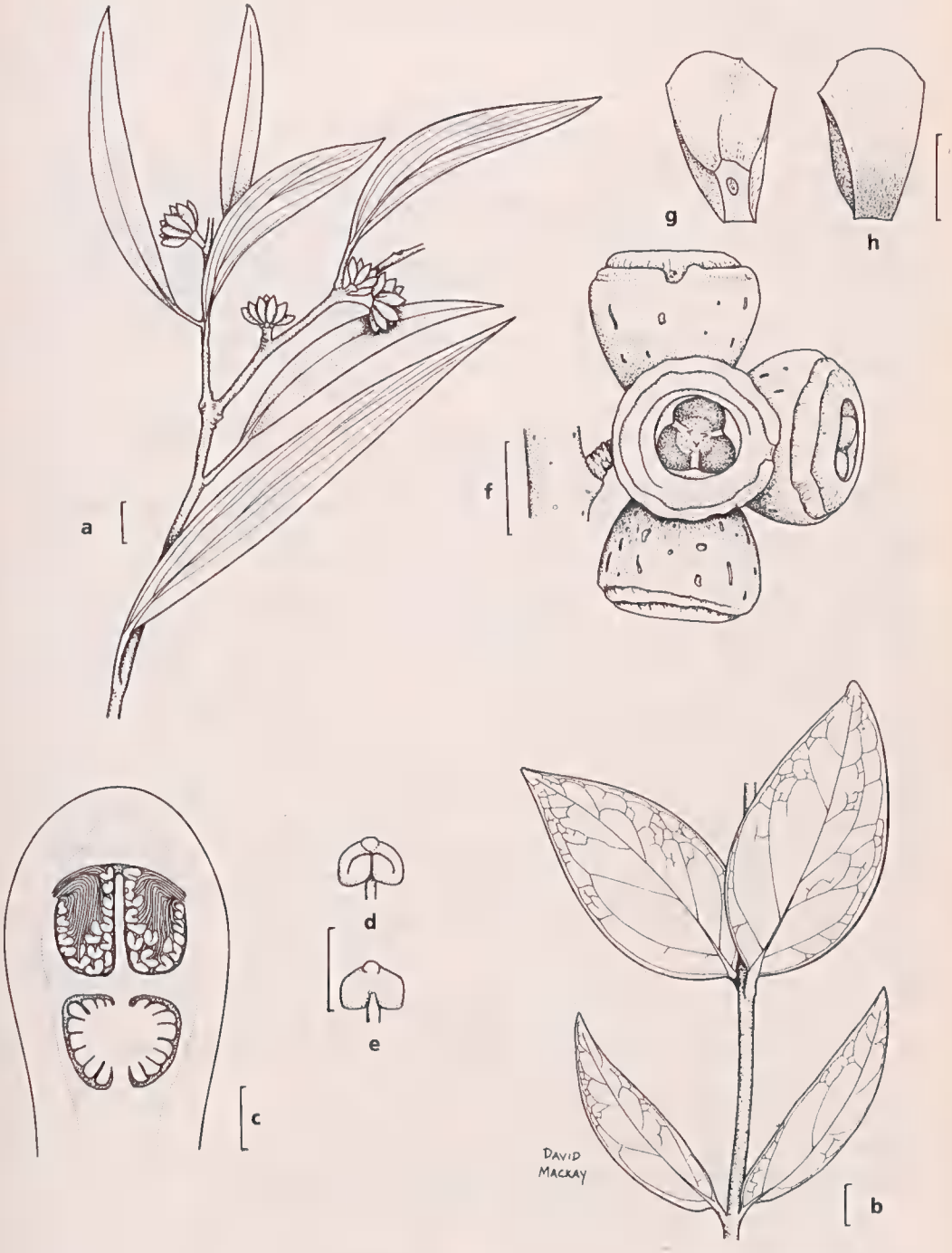

Figure 25. *E. lacrimans*. **a,** adult leaves and buds. **b,** juvenile leaves. **c,** median section of bud. **d, e,** anther. **f,** fruit. **g, h,** seed (all from *Hill 740, Johnson & Pryor*). Scale bar: a, b = 1 cm; f = 5 mm; c = 1 mm; d, e, g, h = 0.5 mm; e = 5 mm.

SELECTED SPECIMENS (from 12 examined): NEW SOUTH WALES: Southern Tablelands: 5 km ESE of Yarrangobilly, *Taylor 1319, Jackson & Hadlow*, 4 Feb 1981 (CBG, NSW); 4 km SE of New Adaminaby, *L. Johnson 8411 & A. Johnson*, 24 Apr 1978 (NSW, BRI, CANB, K, MEL); Tantangara airstrip, *Coveny 5452*, 23 Mar 1974 (NSW); Pocket Saddle, head of Goodradigbee River, *Rodd 1663*, 13 Apr 1971 (NSW).

Acknowledgements

Our colleague, Don Blaxell, has contributed in the recognition of many of the new taxa, and is co-author of several species. Thanks are due to Leonie Stanberg, who has provided invaluable assistance through the project and drafted the distribution maps. David Mackay prepared most of the illustrations, and Bob Roden prepared the illustrations of *E. parramattensis* subsp. *decadens*, *E. lockyeri* and *E. serpentinicola*. Lani Retter provided much assistance in earlier stages of the investigations. The work was in part supported by grants from the Australian Biological Resources Study, which are gratefully acknowledged.

References

Blakely, W.F. (1934) *A key to the eucalypts* (The Worker Trustees: Sydney).

Bramwells, H.W. & Whiffin, T. (1984) Patterns of variation in *E. sideroxylon* A. Cunn. ex Woolls. 1. Variation in adult morphology. *Austral. J. Bot.* 32(3): 263–281.

Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants*. Revised Edition. Australian National Parks and Wildlife Service, Special Publication 14.

Chippendale, G.M. (1988) *Flora of Australia* Volume 19, Eucalyptus, Angophora *(Myrtaceae)* (Australian Government Publishing Service: Canberra).

Johnson, L.A.S. (1972) Evolution and classification in *Eucalyptus*. *Proc. Linn. Soc. New South Wales* 97: 11–29.

Johnson, L.A.S. & Briggs, B.G. (1984) Myrtales and Myrtaceae – a phylogenetic analysis. *Ann Missouri Bot. Gard.* 71: 700–756.

Johnson, L.A.S. & Hill, K.D. (1990) New taxa and combinations in *Eucalyptus* (Myrtaceae). *Telopea* 4(1): 37–108.

Ladiges, P.Y. (1984) A comparative study of trichomes in *Angophora* Cav. and *Eucalyptus* L'Hérit. *Austral. J. Bot.* 32: 561–574.

Maiden, J.H. (1907) *Forest flora of New South Wales*, Vol. 3, part 25 (Govt Printer: Sydney).

McVaugh, R. (1968) The genera of American Myrtaceae – an interim report. *Taxon* 17: 354–418.

Mueller, F. (1880) *Eucalyptographia* 8 (Govt Printer: Melbourne).

Pryor, L.D. & Johnson, L.A.S. (1971) *A classification of the eucalypts* (ANU Press: Canberra).

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Taxonomic changes in *Persoonia* (Proteaceae) in New South Wales

Peter H. Weston and L.A.S. Johnson

Abstract

Weston, Peter H. & Johnson, L.A.S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. Taxonomic changes in Persoonia *(Proteaceae) in New South Wales.* Telopea *4(1): 269–306.* The *Persoonia nutans – P. myrtilloides* species group is circumscribed and revised, and a key to the group and descriptions of all taxa are provided. Miscellaneous other new taxa are described, and several names are reinstated from synonymy. We discuss the taxonomic status of a number of formal and informal taxa listed in 'Plants of New South Wales' by Jacobs and Pickard. Thirteen new species are described: *Persoonia acuminata* L. Johnson & P. Weston, *P. asperula* L. Johnson & P. Weston, *P. bargoensis* P. Weston & L. Johnson, *P. conjuncta* P. Weston & L. Johnson, *P. cuspidifera* L. Johnson & P. Weston, *P. isophylla* L. Johnson & P. Weston, *P. laxa* L. Johnson & P. Weston, *P. katerae* P. Weston & L. Johnson, *P. oleoides* L. Johnson & P. Weston, *P. procumbens* L. Johnson & P. Weston, *P. rufa* L. Johnson & P. Weston, *P. terminalis* L. Johnson & P. Weston, and *P. volcanica* P. Weston & L. Johnson. Four new subspecies are described: *P. hirsuta* Pers. subsp. *evoluta* L. Johnson & P. Weston, *P. laurina* Pers. subsp. *intermedia* L. Johnson & P. Weston, *P. laurina* Pers. subsp. *leiogyna* L. Johnson & P. Weston and *P. terminalis* subsp. *recurva* L. Johnson & P. Weston. Two new combinations are made: *P. brevifolia* (Benth.) L. Johnson & P. Weston, *P. myrtilloides* Sieber ex Schultes & Schultes f. subsp. *cunninghamii* (R. Br.) L. Johnson & P. Weston. Lectotypes are designated for several species.

Introduction

In the course of our revisionary work on *Persoonia* in eastern Australia we have recognised the existence of a number of new taxa. We have also concluded that it is appropriate to reclassify some named taxa at new ranks. In this paper we have formally made most of these additions and changes so that they are available for the forthcoming second volume of the 'Flora of New South Wales'. Since all of the taxa in the informal *P. nutans – P. myrtilloides* group are subjects of taxonomic change, we are presenting a revision of that group. New taxa and combinations in *Persoonia mollis* are treated by Krauss and Johnson (this issue). In addition, we have concluded that a number of the 'taxa' of *Persoonia* referred to by informal names in Jacobs and Pickard (1981) should not be recognised. We have discussed these here to justify their exclusion from our Flora account.

We have attributed authorship of many of our new taxa to 'L. Johnson & P. Weston'. This is deliberate; they should *not* be cited as 'L. Johnson & P. Weston ex P. Weston & L. Johnson'. The number in brackets following each 'selected specimens' heading refers to the total number of specimens seen.

Codes used to indicate conservation status of rare or endangered taxa follow the conventions outlined by Briggs and Leigh (1988: 7–13); see summary of codes at back of issue.

Morphology

Some of the morphological terms that we use require definition or discussion.

We have classified hairs as either short (longest hairs equal to or less than 0.5 mm long), of moderate length (longest hairs more than 0.5 mm long but less than or equal to 1.5 mm long) or long (more than 1.5 mm long). Where hairs are present, their density is classified as sparse (only a few, scattered hairs), moderately dense (more than a few scattered hairs but not so dense that the underlying epidermis is obscured), or dense (obscuring the underlying epidermis).

Patterns of leaf venation are described as either brochidodromous, following Hickey (1973), or obscure (in preference to Hickey's synonymous term hyphodromous). In brochidodromous venation the basic arrangement of mid- and lateral veins is pinnate but each lateral vein loops distally as it approaches the margin, joining the next most distal lateral vein. Venation is classed as obscure if its pattern is not externally visible in dried leaves.

Inflorescences are described using the terminology of Briggs and Johnson (1979). The inflorescence in all species of *Persoonia* is a botryum, 'A simple blastotelic inflorescence in which the primary axis bears lateral flowers' (Briggs & Johnson 1979: 241). Botrya in *Persoonia* are either auxotelic (the inflorescence axis continues to grow beyond the flowering region into a leafy shoot) or anauxotelic (the inflorescence axis terminates in an aborted vegetative bud at the end of the flowering region of the shoot). Usually the flower-subtending organs (pherophylls) in anauxotelic inflorescences are exclusively scale leaves. In auxotelic inflorescences, however, usually only one or a few basal flowers are subtended by scale leaves, while the more distal flowers are subtended by fully developed leaves. There is often a transition in the pherophylls of an auxotelic inflorescence from basal scale leaves through reduced leaves to full-sized foliage leaves.

Plants of most species of *Persoonia* that produce anauxotelic inflorescences also produce auxotelic inflorescences. The proportion of auxotelic to anauxotelic inflorescences varies amongst these species so the variation in percentages of inflorescence types on a typical herbarium specimen is included in the descriptions. For example, the inflorescences of *P. oleoides* are described as 'anauxotelic (0–92%) or auxotelic (100–8%)'. This means that in the herbarium material examined, the percentage of anauxotelic inflorescences on each specimen varied from 0% to 92%. That is, some specimens had only auxotelic inflorescences while in others up to 92% were anauxotelic.

The tips of the tepals of many species of *Persoonia* are caudate and in bud the tepal-tips of most of these species are coherent, or almost so. In several species such as *P. myrtilloides* Sieber ex Schultes & Schultes f., however, structures that appear to be the homologues of caudate tepal-tips of other species occupy a slightly subterminal position on the abaxial tepal surface. The four tepal-tips in a flower bud are free from each other and may even be recurved to reflexed as in *P. myrtilloides*.

All of the taxa dealt with in this paper share the following characters: anther appendages absent, flowers virtually actinomorphic (the gynoecium is only apparently radially symmetrical, consisting of one carpel with 1–2 laterally attached ovules), gynoecium almost as long as the tepals, anthers held close to one another and to the gynoecium at their bases but each anther recurving (to varying degrees from species to species) towards the tip.

A revision of the *Persoonia nutans – P. myrtilloides* group

The *Persoonia nutans – P. myrtilloides* species group may be defined as consisting of those species of *Persoonia* sens. lat. that have: flowers ± actinomorphic, anther appendages absent, either flowers borne on recurved pedicels or leaves less than 1.2 cm long, and gynoecium consistently glabrous. Whether this group is a clade or just an arbitrarily defined class remains to be determined. However, the species are phenetically similar and one of the characters that all but one of the species share, recurved pedicels, could well prove to be a synapomorphy for the group.

The pedicels in this group are erect to strongly recurved in flower. However, they elongate and usually become more strongly recurved in fruit. There is little doubt that recurved pedicels are apomorphous within *Persoonia*. All of the other genera in the Persoonioideae, *Placospermum*, *Garnieria*, *Toronia* and *Acidonia* sens. strict., have erect pedicels, as do the species groups that are cladistically basal within *Persoonia* (Weston 1983). Although several other species of *Persoonia*, viz. *P. graminea* R. Br., *P. sericea* Cunn. ex R. Br., *P. fastigiata* R. Br. and *P. oblongata* R. Br. also have recurved pedicels, it can be argued that all of these are more closely related to other taxa and that their recurved pedicels evolved convergently.

The Western Australian *P. graminea* seems to be most closely related to an unnamed species from the Stirling Range that has erect pedicels. Together these species seem to be most closely related to a larger group that has erect pedicels (Weston 1983).

P. sericea and *P. fastigiata* consistently possess hairy ovaries, a feature that may group them as sister species, relative to the other taxa that resemble them most closely, *P. rigida*, *P. cuspidifera* and *P. curvifolia*. It seems unlikely that these species are closely related to the *P. nutans – P. myrtilloides* group or any of its constituent species.

P. oblongata resembles the *P. nutans – P. myrtilloides* group more closely but it differs in having leaves that are always twisted at the base so that the lamina lies in a vertical plane, and is concolorous with flat margins. Also, individual specimens of this species often possess a hairy ovary. These characters suggest that *P. oblongata* may be more closely related to *P. marginata*, a species with erect pedicels.

The only species in the *P. nutans – P. myrtilloides* group in which the pedicels are not recurved, even in fruit, is *P. terminalis*. This species has relatively small leaves, a character that it shares with *P. acuminata*, *P. recedens*, *P. oxycoccoides*, *P. microphylla* and *P. asperula*. If small leaves is a synapomorphy grouping these species, then erect pedicels probably evolved secondarily in *P. terminalis*. *P. terminalis* has relatively very short (1–2 mm) pedicels and perhaps this feature precludes the development of recurvature.

One of us (LJ in Jacobs & Pickard 1981) had earlier treated *P. nutans* sens. lat. as a widespread, geographically variable species that included seven informal subspecies. We now believe that those subspecies (plus two additional taxa that were referable to *P. nutans* sens. lat.) are best treated as species (one with two subspecies). Our reasoning for this changed circumscription is set out below.

Most of the taxa previously included in *P. nutans* sens. lat. (*P. nutans*, *P. bargoensis*, *P. laxa*, *P. acuminata*, *P. recedens*, *P. terminalis*, *P. oxycoccoides*, *P. microphylla* and *P. asperula*) are morphologically quite distinct. Earlier we had thought that *P. bargoensis* consisted of specimens sampled from a cline linking *P. nutans* and *P. oxycoccoides*. After further sampling, however, it became clear that *P. bargoensis* is a discrete taxon. Only *P. oxycoccoides* and *P. acuminata* seem to intergrade and they do so in a geographically limited area.

It might then be suggested that *P. acuminata* should be reduced to a subspecies of *P. oxycoccoides*. However, there is no apparent synapomorphy linking these taxa, so a more broadly circumscribed *P. oxycoccoides* could well be paraphyletic. Although some taxa such as *P. myrtilloides* and *P. terminalis* possess clear synapomorphies, overall the *P. nutans* – *P. myrtilloides* group cannot at present be resolved in terms of precise cladistic relationships.

Another approach would be to expand the limits of *P. nutans* further to include *P. myrtilloides* and *P. brevifolia* as well. However, *P. myrtilloides* and *P. recedens* occur sympatrically in the higher Blue Mountains with only sporadic hybridisation and it is clear that these taxa are reproductively isolated from each other, thus warranting specific rank.

It should be noted that *P. nutans* subsp. C in Jacobs and Pickard (1981) comprises two species recognised here, *P. acuminata* and *P. recedens*. Specimens collected since subsp. C was circumscribed (by LJ in the early 1950s) have emphasised the distinctiveness of the populations in the higher Blue Mountains so that it now seems reasonable to recognise them formally. The name *P. oxycoccoides* Sieber ex Sprengel was misapplied in being listed as a synonym of *P. nutans* subsp. C in Jacobs & Pickard (1981). The type of *P. oxycoccoides* is a specimen of the taxon that was then treated as *P. nutans* subsp. E.

The species that were previously included in *P. nutans* sens. lat. as subspecies show a geographic replacement pattern, with the different species occurring in different habitats and often separated by major topographic barriers such as river valleys.

The following is a general description of the *P. nutans* – *P. myrtilloides* species group.

Prostrate to erect shrubs. Bark smooth. Hairs whitish to greyish, appressed to patent. Leaves not consistently twisted, not pungent, green when fresh. Flowers ± actinomorphic. Pedicels erect to recurved. Tepals yellow. Anthers yellow, lacking appendages. Ovary glabrous.

The species are ordered on the basis of apparent phenetic similarity.

Key to species

1 Width:length ratio of leaves 1:7 to 1:20, leaves usually linear, mostly < 2.0 mm wide
  2 Leaves linear-lanceolate to lanceolate ..... **9. P. bargoensis**
  2* Leaves linear-oblong
    3 Erect to spreading shrub; leaves 1.5–3.0 cm long, strongly discolorous when dried ..... **10. P. nutans**
    3* Prostrate or decumbent shrub; leaves 0.8–1.5 cm long, slightly discolorous when dried ..... **11. P. laxa**
1* Width:length ratio of leaves > 1:7, leaves not linear, 1.2–30 mm wide
  4 Tepals prominently caudate with recurved to reflexed tips **1. P. myrtilloides**
  4* Tepals apiculate to acute or shortly caudate with straight tips
    5 Leaves mostly < 2.0 mm wide, 0.4–1.1 cm long; inflorescences mostly terminal, anauxotelic ..... **8. P. terminalis**
    5* Leaves usually > 2.0 mm wide, 0.3–2.5 cm long; inflorescences terminal or axillary, auxotelic
      6 Mature leaves scabrous with antrorse to patent hairs; leaves convex with recurved to revolute margins, broad-elliptical to ovate to broad-ovate ..... **7. P. microphylla**
      6* Mature leaves smooth and glabrescent to scaberulous with appressed hairs; leaves flat with flat to recurved margins, ovate

7 Pedicels sparsely to moderately hairy; tepals glabrous to moderately hairy; leaves sparsely to moderately hairy when immature, remaining so when mature ..... **6. P. asperula**
7* Pedicels and tepals glabrous (or rarely the pedicels very sparsely hairy); leaves sparsely (or rarely moderately) hairy when immature, glabrescent to sparsely hairy when mature
8 Longest leaves 1.1 cm long or less ..... **5. P. oxycoccoides**
8* Longest leaves > 1.1 cm long
9 Leaves acute, concolorous to slightly discolorous, with flat to slightly recurved margins, 1.2–3.5 mm wide ... . **4. P. recedens**
9* Leaves usually acuminate, usually strongly discolorous, with recurved margins, 2.5–8.5 mm wide
10 Tepals shortly caudate; leaves and flowers usually turning dark brown to black on drying .... **2. P. brevifolia**
10* Tepals acute to apiculate; leaves usually turning mid-brown on drying ..... **3. P. acuminata**

1. Persoonia myrtilloides *Sieber ex Schultes & Schultes f.*
(Schultes & Schultes 1827: 272)

Type citation: '*Sieber. Herb. nov. Holl. Nro.* 52.'

Lectotype (here designated): M. Residual syntypes: K, M, MEL, NSW, NY.

Linkia myrtilloides (Sieber ex Schultes & Schultes f.) Kuntze (Kuntze 1891: 579).

Erect to spreading shrubs, 0.5–2.5 m high. *Hairs* of moderate length (0.1–0.8 mm long), appressed to patent. *Young branchlets* moderately hairy; internodes 0–15(–38) mm long. *Leaves* alternate, narrowly to broadly elliptic to ovate, acuminate to mucronate, 1.2–5.0 cm long, 4–30 mm wide, flat, with slightly recurved margins, spreading to suberect, sometimes slightly incurved, not falcate, sparsely to moderately hairy when immature, glabrescent when mature, smooth to moderately scabrous; midvein usually evident on both surfaces, venation brochidodromous but often obscure. *Inflorescences* auxotelic, 1–40-flowered; rachis 0–17 cm long; flowers subtended by scale leaves or leaves. Pedicels 2–10 mm long, spreading to recurved, sparsely to moderately hairy. *Tepals* 9–12 mm long, prominently caudate with recurved to reflexed tips, sparsely to moderately hairy. *Ovules* 2. *Drupes* green suffused with purple. *Cotyledons* 4–6.

Flowering period: December to April.

Distribution: From the upper Goulburn River through the Wollemi district to Wentworth Falls in the upper Blue Mountains, in eastern New South Wales.

Notes: *P. myrtilloides* seems to be a clade, characterised by synapomorphous tepal-tips. These are caudate, like the tepal-tips of many other species of *Persoonia*, but they are subterminal on what appears to be the abaxial tepal surface, and recurved to prominently reflexed. It most closely resembles *P. brevifolia*, but its cladistic relationships are unclear. The leaves and flowers of both *P. brevifolia* and *P. myrtilloides* tend to turn dark brown to black on slow drying, while other species in the *P. nutans* – *P. myrtilloides* group turn paler brown. This feature might be a synapomorphy for these species but it is one that occurs in other members of the Proteaceae, including several other species of *Persoonia*.

P. myrtilloides often occurs sympatrically, and occasionally hybridises, with *P. recedens*, *P. acerosa* and *P. levis*. It also sometimes grows with *P. chamaepitys*, *P. linearis* and *P. laurina*.

Morphological variation in *P. myrtilloides* is geographically correlated, ranging from populations with small, broad-elliptical leaves and with long, reflexed tepal-tips in the north to those with larger, narrow-elliptical leaves and with shorter, slightly recurved tepal-tips in the south. Geographic variation in leaf morphology seems to be clinal but that in morphology of tepal-tips seems to involve an abrupt transition in the Capertee area. We have chosen (somewhat arbitrarily) to subdivide this geographic variation into two subspecies, on the basis of tepal morphology.

Key to subspecies

1 Tepal-tips recurved, 1.0–2.0 mm long; leaves narrow-elliptic to lanceolate, 2.0–5.0 cm long, 4–12 mm wide ..... **1a.** subsp. **myrtilloides**

1* Tepal-tips prominently reflexed, 2.5–4.5 mm long; leaves mostly broad-elliptic to ovate to lanceolate, 1.2–3.8 cm long, 6–30 mm wide ..... **1b.** subsp. **cunninghamii**

1a. P. myrtilloides subsp. **myrtilloides**

[*P. myrtilloides* subsp. A in Jacobs & Pickard (1981: 181)]

Habitat: Dry sclerophyll eucalypt forest or occasionally in woodland or heath, on sandy, stony or clayey soils derived from sandstone, at altitudes from 900 to 1200 m.

Distribution: Higher Blue Mountains from the Capertee Valley south to Wentworth Falls (Figure 1).

Conservation status: not rare.

Selected specimens (49): New South Wales: Central Tablelands: Excelsior, *Boorman*, Jan 1914 (NSW 21186); Wolgan Gap, *Johnson*, 17 May 1970 (NSW 23518); 0.7 km from Bell–Lithgow road on Clarence sawmill road, *Weston 377*, 21 Jan 1982 (SYD, NSW); Mount Boyce, 33°37'S 150°16'E, *Coveny 4754 & Armstrong*, 4 Dec 1972 (NSW); Wentworth Falls, *Hamilton*, Nov 1913 (NSW 21205).

1b. P. myrtilloides subsp. **cunninghamii** *(R. Br.) L. Johnson & P. Weston*, **comb. et stat. nov.**

Basionym: *Persoonia cunninghamii* R. Br. (Brown 1830: 15)

Type citation: 'Ora orient., prope Port Jackson, 1823. D. Cunningham'. [The 'D' in this and other R. Brown citations is not an initial but stands for 'Dominus', the equivalent of 'Mr'].

Lectotype (here designated): BM. Isolectotypes: K, MEL, NY.

Linkia cunninghamii (R. Br.) Kuntze (Kuntze 1891: 579).

[*P. myrtilloides* subsp. B in Jacobs & Pickard (1981: 181)]

Habitat: Dry sclerophyll eucalypt or *Callitris* woodland to forest on sandy to stony soils derived from sandstone, at altitudes from 470 to 1000 m.

Distribution: From the upper Goulburn River through the Wollemi district to the Capertee River (Figure 1).

Conservation status: not rare.

Selected specimens (24): New South Wales: Central Tablelands: 2 miles [3 km] N of Mt Coricudgy, *Johnson*, 31 Aug 1951 (NSW 21185); Great Dividing Range, 22 km SE of Rylstone, *Streimann 835*, 15 Dec 1973 (NSW ex CBG). Central Western Slopes: 'The Drips', Goulburn River, 32°12'S 149°47'E, *Coveny 9572*, 24 Sep 1977 (NSW); near Munghorn Gap, *Boyd*, 15 Jan 1968 (NSW 71504); 17.1 km NE of Rylstone on road to Growee Gulph, 32°40'S 150°01'E, *Coveny 10502 & Hind*, 16 Dec 1979 (NSW).

2. Persoonia brevifolia *(Benth.) L. Johnson & P. Weston*, **comb. et stat. nov.**

Basionym: *Persoonia myrtilloides* var. *brevifolia* Benth. (Bentham 1870: 401).

Type citation: 'Upper Genoa River and Nangatta [Nungatta] mountains up to 4000 ft. elevation, *F. Mueller*'.

Syntypes: Upper Genoa River, *F. Mueller*, Sep 1860 (K, MEL, NSW); Nangatta [Nungatta] mountains, *F. Mueller*, – (MEL, NSW).

[*P.* sp. C (aff. *myrtilloides*) in Jacobs & Pickard (1981: 182)]

Erect shrub 0.8–1.5 m high. *Hairs* of short to moderate length (0.2–0.6 mm long),

Figure 1. Distributions of *Persoonia myrtilloides* subsp. *myrtilloides* (■), *P. myrtilloides* subsp. *cunninghamii* (▲) and *P. brevifolia* (●).

appressed to antrorse. *Young branchlets* moderately hairy; internodes 0–18(–37) mm long. *Leaves* alternate, elliptic to broad-elliptic to ovate or obovate, acuminate to mucronate, 1.0–2.5 cm long, 3–12 mm wide, flat, with slightly recurved margins, mostly spreading, not falcate, slightly to strongly discolorous, sparsely hairy when immature, glabrescent when mature, smooth; midvein evident on the abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–10-flowered; rachis 0–5.0 cm long; flowers mostly subtended by leaves. Pedicels 2–5 mm long, erect to recurved, glabrous to sparsely hairy. *Tepals* 8–12 mm long, shortly caudate, glabrous to sparsely hairy. *Ovules* 1 or 2. *Cotyledons* not known.

Flowering period: December to March.

Habitat: Dry to wet sclerophyll eucalypt forest on stony, well-drained soils derived from granitic rocks or sandstone, at 200–1100 m altitude.

Distribution: White Rock Mountain, Mt Wog Wog, Nungatta Peak, and Mt Imlay in far south-eastern New South Wales, also the upper Genoa River in far eastern Victoria (Figure 1).

Conservation status: 2RCa.

Notes: *P. brevifolia* is not known to occur sympatrically with any other species of *Persoonia*.

Selected specimens (14): New South Wales: Southern Tablelands: White Rock Mtn, 37°05'S 149°23'E, *Beesley 315 & Binns*, 26 Mar 1985 (NSW ex CBG); Wog Wog Mtn, 37°06' S 149°25' E, *J.D. Briggs 1795 & Weston*, 26 Mar 1985 (NSW ex CANB); summit of Mt Imlay, 37°11'S 149°44'E, *Albrecht 196 & Conn*, 21 Feb 1984 (NSW ex MEL). Victoria: slopes above S bank of Yambulla Ck, 37°17'S 149°23'E, *Albrecht 3696*, 8 Sep 1988 (NSW ex MEL).

3. Persoonia acuminata *L. Johnson & P. Weston*, **sp. nov.**

Folia plerumque acuminata, 0.8–2.2 cm longa, 2.5–8.5 mm lata, plana marginibus recurvis, plerumque valde discoloria, immaturitate sparse pilosa, maturitate laevia glabrescentiaque. Pedicelli tepalaque glabra. Antherae flavae, sine appendice. Ovarium glabrum.

Holotype: New South Wales: Northern Tablelands: Racecourse Track, 0.4 km NE of junction with Werrikimbe Trail, 31°08'S 152°18'E, *P.H. Weston 1169 & P.G. Richards*, 30 Jan 1988 (NSW).

P. oxycoccoides var.? *longifolia* Benth. (Bentham 1870: 401)

Type citation: 'New England, *C. Stuart*'.

Type: not found, but a specimen of *P. acuminata* at K labelled 'New England', collected by C. Moore, was determined as var. *longifolia* by Bentham.

[*P. nutans* subsp. C p.p. in Jacobs & Pickard (1981: 182)]

Prostrate to spreading shrubs, to 1.7 m high. *Hairs* short (0.1–0.4 mm long), appressed to antrorse. *Young branchlets* moderately hairy; internodes 0–10(–30) mm long. Leaves alternate to subopposite, narrowly to broadly elliptical to ovate to obovate or narrow-oblong, usually acuminate, 0.8–2.2 cm long, 2.5–8.5 mm wide, flat, with recurved margins, usually spreading though sometimes with a prominently recurved tip, not falcate, slightly to strongly discolorous, sparsely hairy when immature, glabrescent to very sparsely so when mature, smooth but sometimes with longitudinal wrinkles abaxially when dried; midvein often evident towards base of abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–16-flowered; rachis 0–7.5 cm long; flowers mostly subtended by reduced leaves or leaves.

Pedicels 3–6 mm long, erect to spreading, glabrous. *Tepals* 7–10 mm long, apiculate, glabrous, yellow. *Ovule* 1. Drupes green. *Cotyledons* not known.

DERIVATION OF EPITHET: Latin *acuminatus*, acuminate, in reference to the leaf tips.

FLOWERING PERIOD: December to April.

HABITAT: Heath to wet sclerophyll eucalypt forest, at 1000 to 1500 m altitude, on well-drained soils, usually derived from granite or metasediments, or on basic volcanic substrates in high-rainfall areas.

DISTRIBUTION: Disjunctly distributed from the Ebor district to the Barrington Tops of the Northern Tablelands of New South Wales and the Hampton area on the Central Tablelands (Figures 2, 3).

Figure 2. Distributions of *Persoonia acuminata* (▲) (see also Figure 3), *P. acuminata* – *P. oxycoccoides* intergrades (○), *P asperula* (■), *P. bargoensis* (□), *P. laxa* (▽), *P. microphylla* (▼), *P. nutans* (◆), *P. oxycoccoides* (●) and *P. recedens* (△).

Conservation status: not rare.

Notes: The other taxon included in *P. nutans* subsp. C in Jacobs and Pickard (1981) was *P. recedens* Gandoger. This taxon is distinguished from *P. acuminata* by its leaves, which are acute (never acuminate), concolorous to slightly discolorous, with flat to slightly recurved margins, 1.2–3.5 mm wide.

P. acuminata apparently intergrades with *P. oxycoccoides* in a limited area between Jenolan Caves and Kanangra Walls at the southern end of its distribution (see figure 2). These specimens have ovate to broad-ovate or orbicular leaves that, on average, are shorter than those of *P. acuminata*.

The northern populations of *P. acuminata* are separated from *P. recedens* by the Hunter and Capertee River valleys, while to the south these species are separated by the valley of the Coxs River.

Selected specimens (21): New South Wales: Northern Tablelands: Point Lookout, *Johnson*, 2 Feb 1951 (NSW 17995); Thumb Rd off Hastings Forest Highway, 31°08'S 152°20'E, *Whaite 3758*, 28 June 1981 (NSW); Dilgry Circle, c. 1 km N of Dilgry River, 31°53'S 151°32'E, *Rodd 4706 & Parsons*, 21 Aug 1986 (NSW). Central Tablelands: Mt Bindo, 1.3 km NW of Tower, 33°41'S 150°00'E, *Benson 2302 & Keith*, 14 Feb 1985 (NSW).

4. Persoonia recedens *Gandoger*
(Gandoger 1919: 227)

Type citation: 'Australia. N.S.Wales. Blackheath. Walter'.

Holotype: Blackheath N.S.W., *C. Walter*, Dec 1882 (LYON).

[*P. nutans* subsp. C p.p. in Jacobs & Pickard (1981: 182)]

Decumbent to spreading shrubs, 0.3–1.5 m high. *Hairs* short (0.1–0.4 mm long), appressed. *Young branchlets* sparsely to moderately hairy; internodes 0–6(–12) mm long. *Leaves* alternate to subopposite, narrow-oblong to narrow-elliptical, acute, 1.0–2.0 cm long, 1.2–3.5 mm wide, flat, with flat to recurved margins, usually suberect, not falcate, concolorous to slightly discolorous, sparsely hairy when immature, glabrescent when mature, smooth but with prominent longitudinal wrinkles abaxially when dried; venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–12-flowered; rachis 0–2.3 cm long; flowers subtended by reduced leaves or leaves. *Pedicels* 2.0–3.5 mm long, glabrous. *Tepals* 9–10 mm long, apiculate, glabrous. *Ovule* 1. *Drupes* green. *Cotyledons* not known.

Flowering period: December to January, with sporadic flowering as late as June.

Habitat: Dry sclerophyll eucalypt forest, at 630 to 1170 m altitude, on sandy, siliceous soils, usually derived from Narrabeen Sandstone.

Distribution: Newnes Plateau to Blackheath, in central-eastern New South Wales with a dubious, disjunct record from Abercrombie Caves. (Figure 2).

Conservation status: 2R.

Notes: *P. recedens* most closely resembles *P. acuminata*, and occurs between the disjunct parts of the distribution of the latter taxon, on a different substrate (sandstone) and in different plant communities. The supposed Abercrombie Caves locality is open to doubt, since that area differs geologically from the rest of the range of *P. recedens*, and the collector is known to one of us (LJ) to have made occasional (though rare) errors in locality recording.

Selected specimens (13): New South Wales: Central Tablelands: near Bungleboori, Newnes State Forest, 33°24'S 150°12'E, *Johnson 8459*, 14 Apr 1979 (NSW); 0.7 km from Bell–Lithgow road on

Clarence sawmill road, *Weston 372*, 21 Jan 1982 (SYD, NSW); Blackheath, *Betche*, Dec 1882 (NSW 20904); Abercrombie Caves, *Constable* 22 Oct 1958 (NSW 56617).

5. Persoonia oxycoccoides *Sieber ex Sprengel*
(Sprengel 1827: 45)

Type citation: 'Sieb. ... *Nov. Holl.*'.

Lectotype (here designated): *Sieber 49*: B. Isolectotypes: K, M (2 sheets), MEL, NY.

Linkia oxycoccoides (Sieber ex Sprengel) Kuntze (Kuntze 1891: 579).

P. thymifolia Cunn. ex R. Br. (Brown 1830: 15). Type citation: 'Ora orient., prope Port Jackson, 1823. *D. Cunningham.*' Syntypes: Argyle, *A. Cunningham*, Apr 1824 (BM, K).

[*P. nutans* subsp. E in Jacobs & Pickard (1981: 182)]

Prostrate to spreading shrubs, to 0.9 m high. *Hairs* short (0.1–0.4 mm long), appressed to antrorse. *Young branchlets* sparsely to moderately hairy; internodes 0–6(–10) mm long. *Leaves* alternate to subopposite, narrowly to broadly elliptical to ovate, acute to acuminate or obtuse, 0.4–1.1 cm long, 1.5–6 mm wide, flat, with recurved margins, spreading, not falcate, slightly to strongly discolorous, sparsely to moderately hairy when immature, glabrescent to sparsely so when mature, smooth to slightly scaberulous; venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–13-flowered; rachis 0–3.5 cm long; flowers subtended by reduced leaves or leaves. *Pedicels* 2–5 mm long, glabrous or rarely very sparsely hairy. *Tepals* 8–11 mm long, acute to apiculate, glabrous. *Ovule* 1 or rarely the odd flower with 2. *Drupes* green. *Cotyledons* 4.

Flowering period: December to April.

Habitat: Heath to dry sclerophyll eucalypt forest, at 600 to 700 m altitude, on acid, sandy soils derived from sandstone.

Distribution: An area bounded by Mittagong, Jamberoo Pass and Tallong on the Central Tablelands of New South Wales (Figure 2).

Conservation status: 2RCa.

Notes: There is more or less clinal variation in leaf shape between the eastern and western parts of the species' range. Longer-, narrower- leaved plants (typical) occur in the west, and shorter-, broader- leaved plants in the east. *P. oxycoccoides* grows sympatrically with *P. levis*, *P. mollis* and *P. laurina* and occasionally hybridises with the first of the species.

Selected specimens (23): New South Wales: Central Tablelands: Mittagong, *Dixon*, – (NSW 21143); c. 2 km N of Dhruwalga Trig on Jamberoo–Robertson road, *Weston 106*, 13 Jan 1980 (SYD); near Fitzroy Falls, *Gauba*, 7 Jan 1953 (NSW ex CBG); Bundanoon, *Moore 3593*, Dec 1962 (NSW ex CANB); Penrose, *Lindsay*, Apr 1936 (NSW 21151).

6. Persoonia asperula *L. Johnson & P. Weston*, **sp. nov.**

Folia anguste oblonga vel oblonga vel elliptica vel ovata, 0.7–2.2 cm longa, 2–6 mm lata, scaberula. Flores regulares. Pedicelli erecti vel patentes, sparse vel modice pilosi. Antherae flavae, sine appendice. Ovarium glabrum.

Holotype: New South Wales: Southern Tablelands: Wadbilliga Fire Trail, c. 25 km SE of Numeralla, 36°20'S 149°32'E, *L.G. Adams & M.P. Austin 2911*, 11 Jan 1973 (NSW). Isotypes (n.v.): CANB, CHR, HBG, K, L, MO, US.

[*P. nutans* subsp. G in Jacobs & Pickard (1981: 182)]

Prostrate to erect shrubs, to 2.0 m high. *Bark* smooth. *Hairs* short (0.1–0.4 mm long), appressed to antrorse. Young branchlets moderately hairy; internodes 0–8(–20) mm long. *Leaves* alternate to subopposite, narrow-oblong to oblong to elliptical or less frequently ovate, acute to obtuse, (0.3–)0.7–2.2 cm long, (1–)2–6 mm wide, flat, with recurved margins, spreading, not falcate, concolorous to strongly discolorous, sparsely to moderately hairy when immature, sparsely to moderately so when mature, scaberulous; midvein sometimes evident towards base of abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–9-flowered; rachis 0–4.5 cm long; flowers mostly subtended by reduced leaves or leaves. *Pedicels* 1–5 mm long, erect to spreading, sparsely to moderately hairy. *Tepals* 9–11 mm long, acute to apiculate, glabrous to moderately hairy. *Ovule* 1. *Drupes* green with purple stripes. *Cotyledons* 5.

Derivation of epithet: Latin *asperulus*, somewhat rough, referring to the leaves.

Flowering period: January to February, with sporadic inflorescences as late as June.

Habitat: Heath dominated by *Allocasuarina nana* to wet sclerophyll eucalypt forest, at 900 to 1350 m altitude, on shallow, stony soils derived from granite or metasediments.

Distribution: From Sandhills Range through the Tinderry and Kybean Ranges to Mt Kydra in New South Wales and in the Moroka River catchment in Victoria (Figure 2).

Conservation status: not rare.

Notes: *P. asperula* most closely resembles *P. oxycoccoides*, which is distinguished by its glabrous or rarely very sparsely hairy pedicels, its glabrous tepals and its leaves, which are sparsely (or rarely moderately) hairy when immature and glabrescent to sparsely hairy when mature.

The single specimen from eastern Victoria, sampled from a population of two plants, differs from the New South Wales specimens in having smaller (0.3–0.8 cm long, 1–2 mm wide), narrow-elliptical leaves. It has no flowers, so there may be other differences too. This may belong to a different taxon, but more samples and better material are required before we can confidently classify these plants. The large disjunction between New South Wales and Victorian populations is surprising given the existence of apparently suitable habitats in the intervening area.

P. asperula sometimes grows sympatrically with *P. chamaepeuce* and *P. silvatica* and occasionally hybridises with the former species.

Selected specimens (23): New South Wales: Southern Tablelands: Sandhills Ra., Hoskinstown to Braidwood, *Moore*, 19 Nov 1952 (NSW 21139); Tinderry Mtns, 35°40'S 149°15'E, *Adams 2207*, 15 June 1968 (NSW ex CANB); Badja Firetrail, c. 0.3 km from Pikes Saddle, *Weston 69 & Tomlinson*, 2 Dec 1979 (SYD); Wadbilliga Fire Trail, 3 km from Wadbilliga, *Tindale 4034 & Wimbush*, 18 Jan 1975 (NSW, BRI, CANB, K, MEL). Victoria: Nielsons Crag, 37°21'S 146°50'E, *Walsh 1693*, 1 Jan 1987 (NSW ex MEL).

7. P. microphylla *R. Br.*
(Brown 1830: 15)

Type citation: 'Ora orient., prope Port Jackson, 1823. *D. Cunningham.*'

Holotype: Argyle, *A. Cunningham*, Apr 1824 (BM).

P. oxycoccoides var. *microphylla* (R. Br.) Domin (Domin 1921: 584)

[*P. nutans* subsp. F in Jacobs & Pickard (1981: 182)]

Prostrate to erect shrubs, to 2.0 m high. *Hairs* short (0.05–0.3 mm long), mostly antrorse to patent. *Young branchlets* moderately hairy; internodes 0–3(–6) mm long. *Leaves*

alternate to subopposite, broad-elliptical to ovate to broad-ovate, rounded to acute, 0.3–0.9 cm long, 2–5 mm wide, convex, with recurved to revolute margins, usually recurved towards the tip, spreading at the base, not falcate, slightly discolorous, sparsely to moderately hairy when immature, sparsely so when mature, scabrous; venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–14-flowered; rachis 0–3.0 cm long; flowers mostly subtended by leaves. *Pedicels* 1–3 mm long, erect to spreading, glabrous to moderately hairy. *Tepals* 8–10 mm long, acute to apiculate, glabrous to sparsely hairy. *Ovule* 1. *Drupes* green with purple stripes. *Cotyledons* 4.

Flowering period: December to February, occasionally with a few sporadic inflorescences throughout the year.

Habitat: Heath to dry sclerophyll eucalypt forest, on sandy to stony soils derived from sandstone or other siliceous rocks, at altitudes from 600 to 1200 m.

Distribution: Disjunctly distributed in eastern New South Wales from the Murruin Range towards Taralga on the Great Divide and in the Corang and Endrick River catchments of the Budawang Range (Figure 2).

Conservation Status: not rare.

Notes: *P. microphylla* grows sympatrically with *P. mollis* subsp. *livens* in the Nerriga area and occasionally hybridises with it. It also grows sympatrically with *P. laurina* subsp. *intermedia* and subsp. *leiogyna*.

Selected specimens (21): New South Wales: Central Tablelands: Mt Werong – South Head, Murruin Ra., *Johnson & Constable*, 24 Oct 1957 (NSW 17756); Richlands to Wombeyan Caves, *Moore 2641*, 13 Oct 1953 (NSW). Southern Tablelands: Bungonia road, 0.7 km ESE of junction with Braidwood–Nerriga road, 35°09'S 150°04'E, *Weston 1423 & Krauss*, 19 Dec 1989 (NSW, AD, BRI, CBG, HO, MEL, PERTH, K, RSA, RB, NBG); head of Endrick River, c. 11 km SE of Nerriga, *Pulley & Telford BR 330*, 20 Dec 1975 (NSW ex CBG); Sallee Creek, 0.5 km S of Fosters Mtn, 35°12'S 150°10'E, *B.G. Briggs 4744*, Sep 1973 (NSW); Charleys Forest, *Baeuerlen*, Sep 1898 (NSW, CBG, MEL,).

8. Persoonia terminalis *L. Johnson & P. Weston*, **sp. nov.**

Folia anguste oblonga, 0.35–1.0 cm longa, 1.2–2.0 mm lata, convexa marginibus recurvis, non torta. Inflorescentiae plerumque terminales anauxotelicaeque, floribus plerumque in axillis foliorum bractiformium. Flores regulares. Pedicelli 1–2 mm longi. Antherae flavae, sine appendice. Ovarium glabrum. Ovula 2.

Holotype: New South Wales: Northern Tablelands: Emmaville–Torrington road, 3.4 km S of Torrington pub, 29°20'S 151°41'E, *P.H. Weston 1439 & P.G. Richards*, 3 Jan 1990 (NSW). Isotypes: AD, BRI, CBG, HO, K, MEL, MO, PERTH, RB.

[*P. nutans* subsp. D in Jacobs & Pickard (1981: 182)]

Erect to spreading shrubs, 0.7–1.5 m high. *Bark* smooth. *Hairs* short (0.1–0.5 mm long), appressed to antrorse. *Young branchlets* sparsely hairy; internodes 0–2(–4) mm long. *Leaves* alternate, narrow-oblong, acute, 0.35–1.0 cm long, 1.2–2.0 mm wide, convex, with recurved margins, usually slightly to strongly recurved towards the tip, spreading at the base, not falcate, not twisted, not pungent, concolorous to slightly discolorous, green, glabrous to sparsely hairy when immature, glabrescent when mature, smooth to slightly scaberulous; venation obscure. *Inflorescences* mostly terminal, mostly anauxotelic, 1–5-flowered; rachis 0–0.7 cm long; flowers mostly subtended by scale leaves. *Pedicels* 1–2 mm long, erect to spreading, sparsely to moderately hairy. *Tepals* 9–13 mm long, obtuse to apiculate, sparsely hairy. *Ovules* 2. *Drupes* green with purple stripes. *Cotyledons* 5.

Derivation of epithet: Latin *terminalis*, terminal, referring to the usually terminal, anauxotelic inflorescences.

Flowering period: December to January, sometimes with a few sporadic inflorescences as late as July.

Distribution: Disjunctly distributed in the Cecil Plains – Inglewood area in SE. Queensland, and in New South Wales in the Warialda area on the North Western Slopes, and the Torrington–Binghi area on the western side of the far Northern Tablelands.

Notes: One of us (LJ) had earlier treated this taxon as an unnamed subspecies of a polymorphic *P. nutans* (see Jacobs & Pickard 1981, as *P. nutans* subsp. D), that included *P. oxycoccoides* and other taxa as informal subspecies. Stanley & Ross (1986) treated it, reluctantly, as a subspecies of *P. oxycoccoides*, and we now agree with them that it should be treated as a distinct species. See also our discussion, above, of *P. oxycoccoides*.

P. terminalis is distinguished from its close relatives by its small, coriaceous leaves and the apparently autapomorphous inflorescences that are mostly terminal and anauxotelic, with flowers subtended mostly by scale leaves.

P. terminalis grows sympatrically with *P. cornifolia* and *P. sericea*, with which it occasionally hybridises, and *P. tenuifolia*.

We recognise two allopatric subspecies within *P. terminalis*.

Key to subspecies

1 Leaves slightly recurved towards the tip; longest leaves 0.8–1.0 cm long ..... **8a.** subsp. **terminalis**

1* Leaves strongly recurved towards the tip; longest leaves 0.6–0.75 cm long ..... **8b.** subsp. **recurva**

8a. P. terminalis subsp. **terminalis**

Shrubs 0.9–1.5 m high. Leaves 0.6–1.0 cm long, slightly recurved towards the tip. Tepals 10–13 mm long.

Habitat: Dry sclerophyll forest on sandy, stony soils derived from acid granite, at altitudes from 900 to 1100 m.

Distribution: Torrington–Binghi area on the western side of the far Northern Tablelands (Figure 3).

Conservation status: 2R.

Selected specimens (7): New South Wales: Northern Tablelands: Bismuth, *Boorman*, Jan 1916 (NSW 20905); 4 km from Torrington along road to Emmaville, 29°20'S 151°41'E, *Crisp 7523*, 31 Oct 1984 (NSW ex CBG); near Emmaville, *Schumacher*, July 1954 (NSW 40156).

8b. P. terminalis subsp. **recurva** *L. Johnson & P.Weston*, **subsp. nov.**

Ab subspecie *terminali* characteribus sequentibus distinguitur: folia 0.35–0.75 cm longa, apicem versus valde recurva; tepala 9–10 mm longa.

Holotype: New South Wales: North Western Slopes: Warialda, *H.M.R. Rupp*, Jan 1907 (NSW 21138).

Shrubs, 0.5–1.0 m high. Leaves 0.35–0.75 cm long, strongly recurved towards the tip. *Tepals* 9–10 mm long.

Derivation of epithet: Latin *recurvus*, curved back, referring to the leaf as a whole, not to the margins.

Habitat: Dry sclerophyll forest on sandy soils derived from sandstone, at altitudes from 350 to 450 m.

Distribution: Disjunctly distributed in the Cecil Plains – Inglewood area in SE. Queensland, and in New South Wales in the Warialda area on the North Western Slopes. (Figure 3).

Conservation status: 3R.

Selected specimens (11): New South Wales: North Western Slopes: about 4 miles [6 km] SE of Coolatai, *Lane 10*, Dec 1972 (NSW); Mosquito Ck Rd, 9.1 km from Warialda, 29°30'S 150°30'E, *Weston 1104, Johnson & Hill*, 20 Oct 1987 (NSW); Apex Park on Gwydir Highway, 1.6 km ESE of Warialda, 29°33'S 150°35'E, *Coveny 12352 & Dalby*, 10 Sep 1986 (B, BRI, K, NSW, PERTH, RSA). Queensland: Darling Downs: SW of Cecil Plains, *Hockings & Cockburn*, Sep 1961 (BRI 030185); Whetstone State Forest, *Smith 5*, Aug 1922 (BRI 261035, 203321, NSW).

Figure 3. Distributions of *Persoonia acuminata* (▲) (see also Figure 2), *P. terminalis* subsp. *terminalis* (◇) and *P. terminalis* subsp. *recurva* (○).

9. Persoonia bargoensis *P. Weston & L. Johnson*, **sp. nov.**

Folia lineari-lanceolata vel lanceolata, 0.8–2.4 cm longa, 1.0–2.0(–2.3) mm lata, plana vel convexiuscula. Flores regulares. Pedicelli 3–7 mm longi, patentes vel recurvi, glabri. Tepala glabra. Antherae flavae, sine appendice. Ovarium glabrum.

HOLOTYPE: NEW SOUTH WALES: Central Coast: Douglas Park Rd, 0.5 km SE of bridge over South Western Freeway, 34°12'S 150°42'E, *P.H. Weston 1414 & S. Krauss*, 18 Dec 1989 (NSW). ISOTYPES: AD, BRI, CBG, HO, K, MEL, MO, PERTH, RB.

Erect shrubs, 0.6–2.5 m high. *Hairs* short (0.1–0.4 mm long), appressed. *Young branchlets* sparsely to moderately hairy; internodes 0–7(–20) mm long. *Leaves* alternate, linear-lanceolate to lanceolate, acute to acuminate, 0.8–2.4 cm long, 1.0–2.0(–2.3) mm wide, flat or convex, with recurved margins, sometimes recurved towards the tip, mostly spreading at the base, not falcate to slightly falcate, slightly to strongly discolorous, green, glabrous to sparsely hairy when immature, glabrescent when mature, smooth; midvein occasionally evident on abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–20-flowered; rachis 0–6 cm long; flowers mostly subtended by leaves. *Pedicels* 3–7 mm long, spreading to recurved, glabrous. *Tepals* 7–10 mm long, shortly caudate, glabrous, yellow. *Anthers* yellow. *Ovary* glabrous. *Ovule* 1. *Drupes* green.

DERIVATION OF EPITHET: Refers to its occurrence in the Bargo district of New South Wales.

FLOWERING PERIOD: December to January.

HABITAT: Dry sclerophyll eucalypt woodland to forest, on Hawkesbury Sandstone and Wianamatta Shale, at altitudes between 100 and 300 m.

DISTRIBUTION: Catchments of the Cataract, Cordeaux and Bargo Rivers (Figure 2).

CONSERVATION STATUS: 2V.

NOTES: *P. bargoensis* is morphologically intermediate between *P. nutans* and *P. oxycoccoides* and we had earlier thought that the specimens were sampled from a cline between those taxa. It seems clear now, however, that *P. bargoensis* is not part of a cline. Firstly, there is no significant variation evident across its distribution. Secondly, intermediate specimens linking the three taxa have never been collected, despite the accessibility of the relevant areas and attempts to find them. *P. bargoensis* is geographically separated from *P. nutans* by a 40 km disjunction and from *P. oxycoccoides* by a 25 km disjunction. It is distinguished from both of those taxa by its linear-lanceolate to lanceolate leaves.

No hybrids of *P. bargoensis* are known.

SELECTED SPECIMENS (11): NEW SOUTH WALES: Central Coast: Ripponden [Douglas Park], *Caley*, Dec 1802 (NSW ex BM); Appin to Wilton road, above Cataract R., 34°14'S 150°44'E, *Dunn 11 & James*, 1 Nov 1984 (NSW, CBG, MEL); The Pheasants Nest, Nepean River, *Constable 6186*, 12 Oct 1965 (NSW, BRI); Tahmoor to Bargo, *Johnson*, 15 Nov 1949 (NSW 18036).

10. Persoonia nutans *R. Br.*
(Brown 1810: 162)

TYPE CITATION: 'In Novae Hollandiae ora orientali; prope Port Jackson: in sylvis solo arenoso, ad radices montium.'.

LECTOTYPE (here designated): prope Richmond & fl. Nepean, *R. Brown*, – (BM). RESIDUAL SYNTYPES: Nepean, *R. Brown*, – (K); Port Jackson, *R. Brown*, – (NSW ex BM).

Linkia nutans (R. Br.) Kuntze (Kuntze 1891: 579)

P. apiculata Meissner (Meissner 1855: 73); *P. nutans* R. Br. var. *apiculata* (Meissner) Benth. (Bentham 1870: 402). Type citation: 'Port Jackson.–*P. nutans*, A. Cunningham! MSS. (non R. Br.)'. Holotype: Port Jackson, *A. Cunningham*, – (NY).

[*P. nutans* subsp. A in Jacobs & Pickard (1981: 182)]

Erect to spreading shrub 0.5–1.5 m high. *Hairs* short (0.1–0.4 mm long), mostly appressed. *Young branchlets* sparsely to moderately hairy; internodes 0–10(–28) mm long. *Leaves* alternate, linear-oblong, acuminate, 1.0–4.5 cm long, 1.0–1.8(–2.5) mm wide, usually flat, with recurved margins, sometimes recurved towards the tip, mostly spreading, sometimes slightly falcate, strongly discolorous, sparsely hairy when immature, glabrescent when mature, smooth; midvein evident on the abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–40-flowered; rachis 0–25 cm long; flowers subtended by leaves. Pedicels 7–12 mm long, recurved, glabrous. *Tepals* 8.5–11 mm long, shortly caudate, glabrous. *Ovules* 2. *Drupes* green with purple markings.

Flowering period: November to April with a few flowers as late as July.

Habitat: Dry sclerophyll eucalypt forest, on laterite, Hawkesbury Sandstone or alluvial sand at altitudes below 60 m.

Distribution: Cumberland Plain between Richmond, Macquarie Fields, and East Hills, particularly near the Nepean and Georges Rivers (Figure 2).

Conservation status: 2E.

Notes: *P. nutans* sometimes grows with *P. laurina* and *P. hirsuta* but no hybrids are known. This species is restricted to part of the Sydney metropolitan area and most remaining populations are threatened by development for housing and sand mining.

Selected specimens (32): New South Wales: Central Coast: Hawkesbury Agricultural College, Richmond, *Greenwood*, 16 Mar 1910 (NSW 21112); Readymix Sand Mine, Londonderry, 33°38'S 150°43'E, *Weston 1256 & Catling*, 23 Sep 1988 (NSW, K); 1 mile [2 km] E of St Marys, *Johnson & Constable*, 22 Dec 1955 (NSW 36554); Kemps Creek, 33°53'S 150°48'E, *Coveny 11179*, 26 July 1982 (NSW); Georges River opposite East Hills, *Whaite 1123*, 30 Nov 1951 (NSW); Macquarie Fields, *Boorman*, Aug 1914 (NSW).

11. Persoonia laxa *L. Johnson & P. Weston*, **sp. nov.**

Folia linearia, 0.8–1.5 cm longa, 1–1.8 mm lata, plana marginibus recurvis, laevia. Flores regulares. Pedicelli 6–8 mm longi, patentes vel recurvi, glabri. Tepala glabra. Appendix antherae absens. Ovarium glabrum.

Holotype: New South Wales: Central Coast: Manly, *A.A. Hamilton*, June 1908 (NSW 21648).

[*P. nutans* subsp. B in Jacobs & Pickard (1981: 182)]

Decumbent or prostrate shrubs. *Hairs* short (0.1–0.4 mm long), appressed to antrorse. *Young branchlets* sparsely hairy; internodes 0–5 mm long. *Leaves* alternate, linear, 0.8–1.5 cm long, 1–1.8 mm wide, flat, with recurved margins, not falcate, slightly discolorous, sparsely hairy when immature, glabrescent when mature, smooth; midvein often evident on the abaxial surface but otherwise venation obscure. *Inflorescences* axillary to terminal, auxotelic, 1–3-flowered; rachis 0–0.5 cm long; flowers mostly subtended by leaves. *Pedicels* 6–8 mm long, spreading to recurved, glabrous. *Tepals* 8–9 mm long, apiculate, glabrous. *Ovary* glabrous. *Ovules* 2. *Drupes*, cotyledons not known.

Derivation of epithet: Latin *laxus*, loose, referring to the habit.

Flowering period: November to January?

Habitat: Presumably in heath or dry sclerophyll eucalypt woodland or forest.

Distribution: Newport to Manly, Central Coast (Figure 2).

Conservation status: 2X.

Notes: This species may be extinct, being represented only by two old specimens collected from what is now a suburban area of Sydney. It most closely resembles *P. nutans*, of which one of us (LJ) had earlier treated it as a subspecies (subsp. B, Jacobs & Pickard 1981). It differs from *P. nutans* in its lax, prostrate or decumbent habit, its shorter leaves that are only slightly discolorous, and in its generally shorter pedicels.

A specimen from Dee Why, collected in 1922, held at NSW is morphologically intermediate between *P. laxa* and *P. levis* and could be a hybrid of these species.

Other specimen examined: New South Wales: Central Coast: Newport, *Chapman*, 9 Nov 1907 (SYD, NSW).

Miscellaneous new taxa and new combinations

Weston (1983) was unable to resolve the cladistic relationships of many of the eastern Australian species in detail, so the taxa treated in this section are dealt with in alphabetical order.

Persoonia conjuncta *P. Weston & L. Johnson*, **sp. nov.**

Frutices erecti vel arbusculae 2–7 m altae. Cortex pro maxima parte laevis sed in trunco subtiliter fissus. Pili breves vel longiusculi, grisei fulvive, antrorsi. Ramuli novelli modice pilosi. Folia anguste elliptica vel lanceolata, 6–14 cm longa, 10–26 mm lata, plana marginibus plusminusve recurvis. Flores regulares. Tepala sparse vel modice pilosa. Antherae flavae, sine appendice. Ovarium pilosiusculum.

Holotype: New South Wales: North Coast: Mt Yarrahapinni, 30°50'S 152°56'E, *L.A.S. Johnson 8516*, 23 Jan 1980 (NSW).

Isotypes: CBG, K.

Erect shrubs to small trees, 2–7 m high. *Bark* mostly smooth but finely fissured on trunk. *Hairs* of short to moderate length (0.05–0.7 mm long), greyish to tawny, antrorse. *Young branchlets* moderately hairy; internodes 0–36 mm long. *Leaves* alternate, narrow-elliptical to lanceolate, acute to acuminate to mucronate, 6–14 cm long, 10–26 mm wide, flat, with recurved margins (often only slightly so), spreading to suberect, not falcate or rarely slightly falcate, twisted through 0–0.25 turns, not pungent, concolorous to slightly discolorous, green, glabrous to sparsely hairy when immature (but much denser on margins), glabrescent when mature, smooth; venation brochidodromous, evident on both surfaces (though sometimes only faintly so). *Inflorescences* axillary to terminal, usually auxotelic (60–100%); auxotelic inflorescences 1–16-flowered, rachis 0–14 cm long, flowers subtended by scale leaves or leaves; anauxotelic inflorescences 1–3-flowered, rachis 0–0.5 cm long, flowers subtended by scale leaves. *Pedicels* 2–6 mm long, erect, sparsely to densely hairy. *Tepals* 12–13 mm long, acuminate to caudate, sparsely to moderately hairy, yellow. *Anthers* yellow. *Ovary* moderately hairy. *Ovule(s)* 1 or rarely 2. *Drupes* green.

Derivation of epithet: Latin *conjunctus*, joined together, referring to the intermediate character of these populations between *P. media* and *P. stradbrokensis*.

Flowering period: January to February.

Habitat: Dry to wet sclerophyll eucalypt forest on a variety of sedimentary and metamorphic substrates, from near sea level to at least 350 m altitude.

Distribution: Coastal ranges and valleys of New South Wales between the Bellinger and Manning Rivers (Figure 4).

Conservation status: not rare.

Notes: This taxon is a class that encompasses populations that are intermediate

Figure 4. Distributions of *Persoonia conjuncta* (●), *P. cuspidifera* (■), *P. daphnoides* (○), *P. hirsuta* subsp. *hirsuta* (◆), *P. hirsuta-evoluta* intergrades (▼), *P. hirsuta* subsp. *evoluta* (▲), *P. procumbens* (◇), *P. rufa* (△) and *P. volcanica* (□).

between *Persoonia media* and *P. stradbrokensis*, occurring commonly in a quite large geographic area, between the distributions of those species. It might be suggested that the existence of these populations is inconsistent with the recognition of *P. media* and *P. stradbrokensis* as species and that perhaps a single species with three subspecies should be recognised. Such a classification would, however, be potentially misleading, since the detailed cladistic relationships between these taxa and their close relatives are quite unclear, and grouping them together would probably create a paraphyletic taxon. It seems best to name this class of populations as a 'species of convenience', at least until relationships within this group are better understood.

P. conjuncta apparently hybridises sporadically with *P. linearis* where they occur sympatrically.

Selected specimens (15): New South Wales: North Coast: Martells Road, 4.4 km W of Pacific Hwy, 30°31'S 152°58'E, *Weston 1073, Hill & Johnson*, 17 Oct 1987 (NSW); Range Road, Ingalba State Forest, 30°48'S 152°48'E, *Johnson 8705*, 28 Jan 1983 (NSW); Pacific Hwy, 4.2 km N of Cooperabung Ck, 31°15'S 152°49'E, *Weston 1376–1377 & Richards*, 30 Jan 1989 (NSW); Pacific Hwy, between turnoff to Rossglen and Charlies Yard Rd, 31°40'S 152°44'E, *Weston 1378–1379 & Richards*, 30 Jan 1989 (NSW).

Persoonia cuspidifera *L. Johnson & P. Weston*, **sp. nov.**

Folia anguste ad late spathulata, 1–2.0 cm longa, 1.5–5 mm lata, convexa, plusminusve incurva, valde scabra. Flores regulares. Antherae flavae, sine appendice. Ovarium glabrum.

Holotype: New South Wales: North Western Slopes: Newell Hwy, 4.1 km NNE of junction with Oxley Hwy, 31°13'S 149°20'E, *P.H. Weston 1567 & P.G. Richards*, 15 Jan 1990 (NSW). Isotypes: AD, BRI, CBG, K, MEL, MO, PERTH, RB.

P. rigida R. Br. var. *microphylla* Benth., pro parte; non *P. microphylla* R. Br. (Bentham 1870: 400).

Type citation: 'Blue Mountains, *Caley*; Castlereagh, *C. Moore*'. Syntype: Castlereagh River, near Belair, *C. Moore*, – (NSW).

[*P.* sp. D (aff. *rigida*) in Jacobs & Pickard (1981: 182)]

Erect shrubs, 0.3–2 m high. *Bark* smooth. *Hairs* of moderate length, greyish to tawny (0.1–1.1 mm long), appressed to patent. *Young branchlets* moderately to densely hairy; internodes 0–10(–20) mm long. *Leaves* alternate, narrowly to broadly spathulate, acuminate to mucronate, 1–2.0 cm long, 1.5–5 mm wide, convex, slightly to strongly incurved, spreading to suberect, not falcate, not pungent, concolorous, green, sparsely to moderately hairy when immature, glabrescent when mature, strongly papillose-scabrous; venation obscure. Inflorescences axillary to terminal, auxotelic, 1–25-flowered; rachis 0–7 cm long; flowers mostly subtended by leaves. *Pedicels* 2–5 mm long, erect, moderately hairy. *Tepals* 8–15 mm long, apiculate, moderately hairy, yellow marked with amroon on the outside, especially along the amrgins. *Anthers* yellow. *Ovary* glabrous. *Ovule* 1. *Drupes* green with purple stripes. *Cotyledons* 4–5.

Derivation of epithet: Latin *cuspidifera*, bearing a cusp, referring to the leaf-shape.

Flowering period: November to March.

Habitat: Heathy and scrubby understorey of dry sclerophyll communities on sandstone.

Distribution: The southern Pilliga Scrub and foothills of the Warrumbungle Mountains, New South Wales (Figure 4).

Conservation status: 3K.

Notes: *P. cuspidifera* most closely resembles its sister species, *P. curvifolia*, from which it is distinguished by its much broader, spathulate-cuspidate leaves. *P. cuspidifera* and *P. curvifolia* share one obvious synapomorphy: the abaxial surface of the tepals in both species is pigmented with dull dark red, restricted to the tepal-margins in some individuals, but covering the entire surface in others. These species apparently hybridise sporadically where they occur sympatrically in the Pilliga area.

P. cuspidifera apparently hybridises sporadically with *P. sericea*, a species with which it is frequently sympatric.

Selected specimens (21): New South Wales: North Western Slopes: Tummallallee [Timmallallie] Ck, c. 30 miles [48 km] NNE of Coonabarabran on Narrabri road, *Johnson*, 7 Nov 1951 (NSW 21006); 5 miles [8 km] N of Coonabarabran, along Newell Highway, *Richards 18*, 12 July 1966 (NSW ex CBG); 2 miles [3 km] N of Long Ridge, c. 22 miles [35 km] E of Coonabarabran, *Johnson*, 29 Sep 1968 (NSW 86877); Warrumbungle Mountains, *Constable*, 23 May 1948 (NSW 16586, K); Parish of Bomera, County Pottinger, *Taylor*, 25 Feb 1922 (NSW 21009).

P. hirsuta *Pers.*
(Persoon 1805: 118)

Type: None cited. Persoon's description, though brief, clearly applies to what is here taken as the type form of this species. He received his specimens from J.E. Smith. No type specimens have been found at L.

Linkia hirsuta (Pers.) Kuntze (Kuntze 1891: 579)

P. arida Sieber ex Sprengel (Sprengel 1827: 45). Type citation: 'Sieb. ... Nov. Holl.'. Syntypes: (*Sieber 55*): B? n.v., BM, K, NY.

Sieber 55 is a mixed collection of at least two distinct elements, one of which is *P. hirsuta* subsp. *hirsuta*, while another is *P. hirsuta* subsp. *evoluta*.

P. hirsuta [var.] β *subovalis* Endl. (Endlicher 1848: 81) (based on *P. hirsuta* β R. Br. (Brown 1830: 13), which in turn was based on *P. arida*).

Flowering period: Mostly November to January but occasionally as early as September.

Habitat: Dry sclerophyll eucalypt woodland to forest, on sandy to stony soils derived from sandstone, from near sea-level to 600 m altitude.

Distribution: Patchily distributed in an area bounded by Putty, Glen Davis and Gosford, south to Royal National Park and Hill Top, in eastern New South Wales (Figure 4).

Notes: Geographic variation in *P. hirsuta* is clinal, from narrow-leaved populations in the east to broad-leaved populations in the west. Subsp. *evoluta* is arbitrarily distinguished from subsp. *hirsuta* by its broader, obtuse leaves with less prominently recurved margins. Specimens from the lower Blue Mountains and western suburbs of Sydney (and even some specimens from farther east) are intermediate between the extreme eastern and western forms.

The cladistic relationships of *P. hirsuta* are unclear, and it has no obvious close relatives. It is not known to hybridise with any other species.

Key to subspecies

1 Leaves linear to narrow-oblong, acute, 0.75–1.5 mm wide, with revolute margins ..... subsp. **hirsuta**

1* Leaves spathulate to elliptical or narrowly so, mostly obtuse, 1.5–5 mm wide with mostly recurved margins ..... subsp. **evoluta**

P. hirsuta subsp. **hirsuta**

P. hirsuta [var.] α *linearis* Endl. (Endlicher 1848: 81) (based on a reference to *P. hirsuta* α R. Br. (Brown 1830: 13), which by implication is based on *P. hirsuta* Pers.).

[*P. hirsuta* subsp. A in Jacobs & Pickard (1981: 181)]

DISTRIBUTION: From Gosford to Royal National Park, within 20 km of the coast, below 300 m altitude (Figure 4).

SELECTED SPECIMENS (17): NEW SOUTH WALES: Central Coast: Gosford, *Boorman*, Jan 1903 (NSW 20894); Sir Edward Hallstrom Reserve, Cowan, *Metcalf*, – (NSW 94804); Roseville East, *Johnson*, 14 Dec 1952 (NSW 21404); North Head, *Coveny*, 26 Aug 1967 (NSW); [Royal] National Park, *Hamilton*, 9 Nov 1898 (NSW 21776).

P. hirsuta subsp. **evoluta** – subsp. **hirsuta** intergrades

DISTRIBUTION: Maroota to Macquarie Fields, c. 15 to 65 km from the coast, below 300 m altitude (Figure 4).

SELECTED SPECIMENS (20): NEW SOUTH WALES: Central Coast: Maroota, *Blakely & Shiress*, 15 Sep 1929 (NSW 20893); Glenbrook, *Maiden*, Nov 1914 (NSW 21768); 2 km from Windsor Rd along Annangrove Rd, Rouse Hill, *Benson 2382 & Keith*, 18 Oct 1985 (NSW); East Hills Railway Station, *Coveny 451*, 4 Aug 1968 (NSW 112271); Long Point, Macquarie Fields, *McBarron 14804*, 28 Dec 1967 (NSW).

P. hirsuta subsp. **evoluta** *L. Johnson & P. Weston*, **subsp. nov.**

Differt a subspecie *hirsuta* foliis spathulatis ad ellipticis vel angustis, obtusis ad acutis, 1.5–5 mm latis, marginibus plerumque recurvis.

HOLOTYPE: NEW SOUTH WALES: Central Coast: corner of Banksia and Wattle Streets, Hill Top, 34°21'S 150°29'E, *P.H. Weston 432 & J. Dalby*, 15 Jan 1985 (NSW). ISOTYPES: AD, B, BRI, CANB, HO, K, L, MEL, MO, NBG, PERTH, RSA.

P. hirsuta [var.] γ *spathulata* Meissner (Meissner 1856: 337). TYPE CITATION: 'Sieber...n. 529!'. SYNTYPE: BM.

[*P. hirsuta* subsp. B in Jacobs & Pickard (1981: 181)]

DERIVATION OF EPITHET: Latin *evolutus*, unrolled, referring to the broader leaves, in which the margins are not tightly revolute as they are in the type subspecies.

DISTRIBUTION: Sporadically distributed in the Putty, Glen Davis and Hill Top districts, at 350–600 m altitude (Figure 4).

SELECTED SPECIMENS (11): NEW SOUTH WALES: Central Coast: E of Putty, *Johnson*, 20 Sep 1951 (NSW 17863); Green Gully, 1.7 km S of Glen Davis, 33°07'S 150°16'E, *Crisp 2201 & Telford*, 25 Oct 1976 (NSW ex CBG); Balmoral [near Hill Top], *Bingham*, Nov 1896 (NSW 21765); Hill Top, *Maiden*, Jan 1896 (NSW 21766, AD, BRI, CBG, MEL, PERTH).

Persoonia isophylla *L. Johnson & P. Weston*, **sp. nov.**

Folia linearia, 1.2–3.0 cm longa, 0.5 mm lata, teretia, laevia. Inflorescentiae auxotelicae floribus saepissime in axillis foliorum evolutorum. Flores regulares. Antherae flavae, sine appendice. Ovarium glabrum.

Holotype: New South Wales: Central Coast: Peats Ridge–Kulnura road, 1.7 km S of Central Mangrove, 33°18'S 151°14'E, *P.H. Weston 1425 & D.M. Weston*, 26 Dec 1989 (NSW). Isotypes: AD, BRI, CBG, HO, K, MEL, MO, PERTH, RB.

[*P.* sp. A (aff. *pinifolia*) in Jacobs & Pickard (1981: 182)]

Erect to spreading shrubs, 0.3–1.5 m high. *Bark* smooth. *Hairs* of moderate length (0.1–1.4 mm long), greyish, appressed to antrorse. *Young branchlets* sparsely hairy; internodes (0–)0.5–4(–15) mm long. *Leaves* alternate, linear, acuminate, 1.2–3.0 cm long, 0.5 mm wide, terete but grooved underneath when dried, often recurved, spreading, not falcate, not pungent, concolorous, green, glabrous to sparsely hairy when immature, glabrescent when mature, smooth; venation obscure. *Inflorescences* mostly subterminal to terminal, auxotelic, (1–)10–70-flowered; rachis 0.5–9 cm long; flowers mostly subtended by leaves. *Pedicels* 0–1.5 mm long, erect to spreading, glabrous to moderately hairy. *Tepals* 7–8 mm long, apiculate, glabrous to sparsely hairy, yellow. *Anthers* yellow. *Ovary* glabrous. *Ovule* 1. *Drupes* green and usually suffused with reddish purple. *Cotyledons* 5.

Derivation of epithet: Greek *isos*, equal, and *phyllon*, a leaf; referring to the inflorescences in which the flowers are subtended by full-sized leaves, in contrast to the inflorescences of *P. pinifolia*, in which the flowers are subtended by reduced leaves.

Flowering period: January to July.

Habitat: Heath to dry sclerophyll eucalypt forest on sandy or stony soils derived from Hawkesbury Sandstone, from near sea-level to 250 m altitude.

Distribution: Central Coast of New South Wales, from the Gosford–Kulnura district to the Manly district. (Figure 5).

Conservation Status: not rare.

Notes: *P. isophylla* closely resembles *P. pinifolia*, and it seems most likely that they are sister species, sharing the following synapomorphies: linear, terete leaves, the potential to produce acrotonic as well as basitonic inflorescences, many-flowered inflorescences. These species have been confused in the past but *P. isophylla* is distinguished by its shorter, usually brighter green leaves, and its consistently auxotelic inflorescences in which the great majority of flowers are subtended by full-sized leaves. They grow sympatrically south of the Hawkesbury River but hybrids between them seem to be very rare; no other hybrids of *P. isophylla* have been recorded. In general, *P. isophylla* grows in more heathy sites than *P. pinifolia*.

Selected specimens (24): New South Wales: Central Coast: top of Judge Dowling Range, c. 3 miles [4.6 km] SW of Bucketty, *McGillivray 1223*, 5 July 1965 (NSW, CBG, MEL); Kulnura, 33°14'S 151°13'E, *Coveny 5849, Hind & Hancock*, 23 Nov 1974 (NSW, AD, BRI, CBG, MEL, PERTH); near Empire Bay turn-off on Gosford–Kilcare road, *McKern*, 20 Apr 1958 (NSW 43383, CBG, MEL); above 'The Duckhole', near head of McCarrs Ck, W of Church Point, *Johnson*, 20 Feb 1952 (NSW 20991, CBG); Deep Creek, Narrabeen, *Coveny*, 15 Oct 1966 (NSW, CBG); northern end of Manly Dam, 33°47'S 151°14'E, *Taylor 290 & Coveny*, 2 Oct 1984 (NSW, MEL, PERTH).

Persoonia katerae *P. Weston & L. Johnson*, **sp. nov.**

Cortex pro parte maxima laevis sed basin versus subtiliter fissus. Pili breves, griseusculi, adpressi vel antrorsi. Folia anguste elliptica ad oblanceolata, 6–17 cm longa,

8–22 mm lata, marginibus aliquantulo recurvis, recta falcatave, viridia sed in sicco nigrescentia. Flores regulares. Antherae flavae, sine appendice. Ovarium glabrum. Ovula 2.

HOLOTYPE: NEW SOUTH WALES: North Coast: Boomerang Drive, 1.2 km N of Headland Rd, 0.2 km W of Boomerang Beach, 32°20'15"S 152°32'30"E, *P.H. Weston 1124 & P.G. Richards*, 28 Jan 1988 (NSW). ISOTYPES: BRI, CBG, K, MEL, MO.

Erect shrubs or small trees, 2.5–9 m high. *Bark* mostly smooth but rough and finely fissured at base. *Hairs* short (mostly 0.05–0.5 mm long), greyish, appressed to antrorse. *Young branchlets* moderately hairy; internodes 0–45(–65) mm long. *Leaves* alternate, narrow-elliptical to oblanceolate, acute to acuminate, 6–17 cm long, 8–22

Figure 5. Distributions of *Persoonia isophylla* (●), *P. katerae* (▲) and *P. oleoides* (■).

mm wide, flat, with slightly recurved margins, spreading to suberect, not falcate to falcate, twisted through 0–0.25 turns, not pungent, concolorous, green but turning black on natural drying, glabrous to sparsely hairy when immature (but much denser on margins), glabrescent when mature, smooth; venation brochidodromous, usually evident on both surfaces. *Inflorescences* mostly subterminal to terminal, auxotelic, (3–)6–22-flowered; rachis (1–)3–16 cm long; flowers mostly subtended by leaves. *Pedicels* 35 mm long, erect, moderately hairy. *Tepals* 9–12 mm long, acute to acuminate, moderately hairy, yellow. *Anthers* yellow. *Ovary* glabrous. *Ovules* 2. *Drupes* green or green suffused with reddish purple.

Derivation of epithet: In honour of Mrs Penelope Kater, who indirectly drew our attention to this taxon. She has worked as a volunteer, at the National Herbarium of New South Wales, since 1985, assisting in accummulating and curating herbarium specimens of Proteaceous seedlings.

Flowering period: January to February.

Habitat: Heath to dry sclerophyll forest, usually in association with *Banksia integrifolia* or *Eucalyptus pilularis*, exclusively on stabilised coastal sand dunes, at altitudes less than 20 m.

Distribution: Between Lake Cathie and Smiths Lake of north coastal New South Wales (Figure 5).

Conservation status: not rare.

Notes: Surprisingly, this handsome species seems never to have been collected before 1987, although it is common (and in some localities dominant) over quite a wide, accessible area. It most closely resembles *P. media*, *P. conjuncta*, and *P. stradbrokensis*, from which it is distinguished by consistently having 2 ovules per carpel, leaves that turn black on natural drying (check fallen leaves in the field), and in having appressed to antrorse, short, greyish hairs that are moderately dense on the branchlets.

P. katerae and *P. lanceolata* often grow sympatrically and occasionally hybridise.

Selected specimens: New South Wales: North Coast: 0.3 km N of Cathie Ck, on Cathie Rd, 31°33'S 152°51'E, *Weston 1145–1147 & Richards*, 29 Jan 1988 (NSW); Crowdy Head – Diamond Head track, 7 km directly N of Crowdy Head, Crowdy Head National Park, 31°46'S 152°31'E, *Weston 1142–1144 & Richards*, 29 Jan 1988 (NSW); road to Tuncurry tip, 0.1 km NE of Tuncurry Rd, 32°08'S 152°30'E, *Weston 1130–1132 & Richards*, 28 Jan 1988 (NSW); The Lakes Way, Tiona, 32°18'S 152°31'E, *Weston 1117*, 5 Nov 1987 (BRI, CBG, NSW).

Persoonia laurina *Pers.*
(Persoon 1805: 118)

Type: None cited. Persoon's description, though brief, is quite sufficient to characterise the species amongst 'Port Jackson' plants known at that date. He received his specimens from J.E. Smith. No type specimens have been found at L.

Flowering period: November to January.

Habitat: Dry sclerophyll woodland to forest, usually on sandy to stony soils derived from sandstone, or occasionally on sandy alluvium or granite or metasediments, at altitudes from near sea-level to 1200 m.

Distribution: Central-eastern New South Wales, from Port Stephens south to Conjola on the coast and from the Capertee River to the southern Budawang Ranges on the tablelands.

NOTES: *P. laurina* seems to be a clade characterised by its style, which becomes reflexed in fruit. It apparently forms a clade with *P. confertiflora*, characterised by consistently subopposite to opposite leaves, and exclusively anauxotelic inflorescences. The sister species of this clade seems to be *P. silvatica*.

No hybrids of *P. laurina* are known, despite its frequent sympatric occurrence with many other species of *Persoonia*.

Three parapatric subspecific races within *P. laurina* can be diagnosed on the basis of two characters: the presence or absence of scabrous papillae on the mature leaves and a densely hairy or glabrous ovary.

Key to subspecies

1 Ovary densely hairy; mature leaves smooth or scabrous; style strongly reflexed on mature drupe
  2 Mature leaves smooth ..... subsp. **laurina**
  2* Mature leaves scabrous ..... subsp. **intermedia**
1* Ovary glabrous; mature leaves scabrous; style reflexed on mature drupe ..... subsp. **leiogyna**

P. laurina subsp. **laurina**
P. ferruginea Smith (Smith 1806: 47, t. 83)

TYPE CITATION: 'near Port Jackson'.

TYPE: LINN (n.v.).

Linkia ferruginea (Smith) Kuntze (Kuntze 1891: 579)

P. maidenii Gandoger (Gandoger 1919: 227). TYPE CITATION: 'Australia. N.S.Wales ad Port Jackson. Maiden.' HOLOTYPE: Port Jackson District, *J.H. Maiden*, Jan 1893 (LYON).

P. monticola Gandoger (Gandoger 1919: 227) TYPE CITATION: 'Australia. N.S.Wales in Monte Victoria. Walter.' HOLOTYPE: Mount Victoria, *Walter*, Dec 1886 (LYON).

[*P. laurina* subsp. A in Jacobs & Pickard (1981: 181)]

DISTRIBUTION: From the Bulahdelah district to the Georges River on the coast and the Capertee River to Coxs River – Lake Burragorang on the tablelands (Figure 6).

CONSERVATION STATUS: not rare.

SELECTED SPECIMENS (56): NEW SOUTH WALES: North Coast: 2 miles [3 km] W of Karuah, *Johnson*, 12 Oct 1953 (NSW 26376). Central Coast: Maroota, *Blakely & Shiress*, 15 Sep 1929 (NSW 21792); Agnes Banks, *Benson 1034*, 5 Dec 1974 (NSW); Springwood, *Cross*, Mar 1934 (NSW); Hurstville, *Camfield*, Dec 1896 (NSW 21803). Central Tablelands: Excelsior, *Boorman*, Jan 1914 (NSW 20950); Evans Lookout, 33°39'S 150°20'E, *Weston 1274 & Catling*, 31 Oct 1988 (NSW).

P. laurina subsp. **intermedia** *L. Johnson & P. Weston*, **subsp. nov.**

Inter subspeciem *laurinam* et subspeciem *leiogynam*; foliis modice scabris et ovario dense piloso distinguitur.

HOLOTYPE: NEW SOUTH WALES: Central Coast: Banksia St, Hill Top, 34°21'S 150°29'E, *P.H. Weston 1419 & S. Krauss*, 19 Dec 1989 (NSW). ISOTYPES: AD, BRI, CBG, HO, K, MEL, MO, PERTH, RB.

[*P. laurina* subsp. B in Jacobs & Pickard (1981: 181)]

Derivation of epithet: Latin *inter*, between, and *medius*, middle, referring to the combination of characters and the partly intermediate area of occurrence.

Distribution: From the upper Georges River to Bowral and the Wombeyan district (Figure 6).

Conservation status: not rare.

Selected specimens (21): New South Wales: Central Coast: 3 miles [5 km] E of Leumeah, *Johnson*, 6 Nov 1948 (NSW 20730); Yerrinbool, *Johnson*, 15 Apr 1951 (NSW 21808). Central Tablelands: The Gib [Mt Gibraltar], Bowral, *Rupp*, 20 Nov 1945 (NSW 864); Richlands to Wombeyan Caves, *Moore 2642*, 13 Oct 1953 (NSW).

P. laurina subsp. **leiogyna** *L. Johnson & P. Weston*, **subsp. nov.**

Inter subspeciebus combinatione foliorum scabrorum et ovarii glabri distinguitur.

Holotype: New South Wales: Central Tablelands: Wingello, *J.L. Boorman*, Dec 1917 (NSW 21826).

[*P. laurina* subsp. C in Jacobs & Pickard (1981: 181)]

Derivation of epithet: Greek *leios*, smooth, and *gyne*, a woman, referring to the glabrous ovary.

Distribution: From the Jenolan Caves district to the southern Budawang Range and Conjola (Figure 6).

Conservation status: not rare.

Figure 6. Distribution of *Persoonia laurina*: subsp. *laurina* (▲), subsp. *intermedia* (●) and subsp. *leiogyna* (■).

NOTES: This taxon is distinguished from both of the other subspecies by its glabrous ovary. It is further distinguished from subsp. *laurina*, and also from *P. silvatica* and *P. confertiflora*, by its papillose-scabrous mature leaves.

SELECTED SPECIMENS (35): NEW SOUTH WALES: South Coast: Conjola, *Heron*, Nov 1898 (NSW 21831). Central Tablelands: Ruby Creek Falls, Mt Werong State Forest, 34°05'S 149°56'E, *Coveny 12159, Bishop & Makinson*, 18 Sep 1985 (NSW, B, DAR, K, PERTH); Jamberoo Mtn Rd, Carrington Falls, 34°37'S 150°41'E, *Weston 1391 & Bishop*, 7 Apr 1989 (NSW). Southern Tablelands: 8 km E of Nerriga along Nerriga – Nowra road, 35°05'S 150°08'E, *Pullen 10.212*, 2 Dec 1975 (NSW ex CANB); 16 km NNE of Mongarlowe, *Johnson 7247*, 18 Aug 1971 (NSW).

Persoonia oleoides *L. Johnson & P. Weston*, **sp. nov.**

Frutices multicaules erecti vel decumbentes. Ramuli novelli modice ad dense pilosi. Folia variantia: oblonga, elliptica, ovata, obovata, vel anguste rare late spathulata, 2–6(–9) cm longa, 4–15(–26) mm lata, marginibus plusminusve recurvis, concoloria vel subdiscoloria. Flores regulares. Tepala modice pilosi. Antherae flavae, sine appendice. Ovarium glabrum vel rare pilosiusculum.

HOLOTYPE: NEW SOUTH WALES: Northern Tablelands: Styx River Forest Way, 1.9 km NE of Armidale – Kempsey road, 30°36'30"S 152°11'45"E, *P.G. Richards 84 & P.H. Weston*, 31 Jan 1988 (NSW). ISOTYPES: AD, BRI, CBG, K, MEL, MO, PERTH, RB.

Erect to decumbent shrubs, 0.2–1.0 m high. *Bark* smooth. *Hairs* of short to moderate length (0.1–0.9 mm long), greyish to ferruginous, appressed to antrorse. *Young branchlets* moderately to densely hairy; internodes 0–22(–34) mm long. *Leaves* alternate, oblong to elliptical to ovate to obovate to spathulate or narrowly or rarely broadly so, acuminate to mucronate, 2–6(–9) cm long, 4–15(–26) mm wide, flat, with recurved margins (sometimes only slightly so), sometimes incurved, spreading to suberect, not falcate, not pungent, concolorous to slightly discolorous, green, sparsely hairy when immature (but denser on margins), glabrescent to sparsely so on adaxial surface when mature, smooth to slightly scaberulous; venation brochidodromous, obscure to evident on both surfaces. *Inflorescences* axillary to terminal, anauxotelic (0–92%) or auxotelic (8–100%); auxotelic inflorescences 1–25-flowered, rachis 0–13 cm long, flowers subtended by scale leaves or leaves; anauxotelic inflorescences 1–3(–15) -flowered, rachis 0–1.0(–3.5) cm long, flowers subtended by scale leaves. *Pedicels* 1–3 (–5) mm long, erect, moderately to densely (or rarely sparsely) hairy. *Tepals* 10–15 mm long, apiculate to shortly caudate, moderately hairy, yellow. *Anthers* yellow. *Ovary* glabrous or rarely sparsely hairy. *Ovule* 1. *Drupes* green or green with purple stripes or rarely entirely reddish purple.

DERIVATION OF EPITHET: Latin *olea*, olive (i.e. *Olea europaea*, the common olive), with latinised Greek suffix *-oides*, resembling, referring to the shape of the leaves in many individuals.

FLOWERING PERIOD: January to February.

HABITAT: Dry to wet sclerophyll eucalypt forest, on various metamorphic and igneous substrates, common on the eastern side of the Northern Tablelands of New South Wales to an altitude of 1300 m, but also occurring occasionally down to the foot of the eastern escarpment of the tablelands, as low as 190 m altitude.

DISTRIBUTION: Between the upper Clarence River and the upper Macleay River. Absent from, although occurring just west of, the highly siliceous granite country of the Gibraltar Range (Figure 5).

CONSERVATION STATUS: not rare.

NOTES: This species shows remarkable variability in the shape and size of its leaves, and in inflorescence behaviour (individuals can have predominantly auxotelic or anauxotelic inflorescences) but is relatively stable in other characters such as habit. Leaf length seems to be negatively correlated with altitude, and populations from low altitudes tend to be more variable in leaf morphology than those from the tablelands.

P. oleoides forms narrow hybrid zones with *P. cornifolia*, which only occurs to the west of *P. oleoides*. One such zone is found just west of the Styx River bridge on the Armidale–Kempsey road, where, over a distance of perhaps 300 m, plants with apparently random combinations of characters of both parent-species occur. *P. oleoides* often grows sympatrically with *P. media* but these species apperently seldom hybridise.

Until recently we had thought that specimens of *P. oleoides* might be hybrids between *P. cornifolia* and *P. procumbens*. They often appear to be morphologically intermediate between these species and the sympatric occurrence of *P. procumbens* with hybrid swarms of *P. oleoides* and *P. cornifolia* seemed to corroborate this idea. However, populations of *P. oleoides* occur in many localities without any other species of *Persoonia*.

SELECTED SPECIMENS (46): NEW SOUTH WALES: North Coast: Bruxner Hwy at Crooked Creek, 28°55'S 152°17'E, *Weston 1335–1337 & Richards*, 12 Jan 1989 (NSW); 3.8 km N of Georges Creek bridge, Georges Creek Nature Reserve, 30°43'S 152°47'E, *Richards 58–60 & Weston*, 31 Jan 1988 (NSW). Northern Tablelands: Spirabo Firetrail, at gate 1.8 km N of junction with Upper Rocky River Trail, Spirabo State Forest, 29°18'S 152°07'E, *Weston 1327–1328 & Richards*, 25 Jan 1989 (NSW); Gwydir Hwy, 2.1 km SSW of Bark Hut Forest Rd, 29°38'S 152°10'E, *Weston 1433–1434 & Richards*, 2 Jan 1990 (NSW); Chaelundi Mtn, hill on E side of road, Chaelundi State Forest, 30°04'S 152°21'E, *Hill 2737, Johnson & Weston*, 18 Oct 1987 (NSW, BRI, CBG); c. 1 mile [1.6 km] W of Point Lookout, *J.B. Williams*, 12 Feb 1966 (NSW ex UNE).

Persoonia procumbens *L. Johnson & P. Weston*, **sp. nov.**

Frutices prostrati. Pili ferruginei. Folia alterna, saepissime obovata spathulatave, 1.5–3.6 cm longa, 4–17 mm lata, concoloria. Flores regulares. Pedicelli erecti. Tepala modice pilosa. Antherae flavae, sine appendice. Ovarium glabrum.

HOLOTYPE: NEW SOUTH WALES: Northern Tablelands: Point Lookout road, 0.7 km E of Armidale–Ebor road, 30°29'S 152°18'E, *P.G. Richards 92 & P.H. Weston*, 1 Feb 1988 (NSW). ISOTYPES: AD, BRI, CBG, K, MEL, MO, PERTH, RB.

[*P. prostrata* subsp. C in Jacobs & Pickard (1981: 182)]

Prostrate shrubs, to 0.1 m high. *Bark* not well-developed. *Hairs* of short to moderate length (0.1–0.6 mm long), ferruginous, appressed to antrorse. *Young branchlets* moderately to densely hairy; internodes 0–12(–22) mm long. *Leaves* alternate, mostly obovate to spathulate to cuneate, mostly acuminate to mucronate or less frequently acute to obtuse or emarginate, 1.5–3.6 cm long, 4–17 mm wide, flat, with slightly recurved margins, suberect, not falcate, twisted through 0–0.25 turns, not pungent, concolorous, green, sparsely hairy when immature, glabrescent when mature, smooth; venation brochidodromous, obscure to faintly evident. *Inflorescences* axillary to terminal, anauxotelic (0–50%) or auxotelic (50–100%); auxotelic inflorescences 1–6 -flowered, rachis 0–2 cm long, flowers subtended by scale leaves or leaves; anauxotelic inflorescences 1–3-flowered, rachis 0–0.1 cm long, flowers subtended by scale leaves. *Pedicels* 1.5–3 mm long, erect, moderately to densely hairy. *Tepals* 7–9 mm long, apiculate, sparsely hairy, yellow. *Anthers* yellow. *Ovary* glabrous. *Ovule(s)* 1 or rarely 2. *Drupes* green. *Cotyledons* 4.

Derivation of epithet: Latin *procumbens*, lying forward, referring to the habit.

Flowering period: December to February.

Habitat: Dry sclerophyll eucalypt woodland to forest on sandy to clayey soil derived from granite (adamellite or leucoadamellite), at 1200 to 1500 m altitude.

Distribution: Backwater and Round Mountain areas, New England (Figure 4).

Conservation status: 2RC-.

Notes: *P. procumbens* resembles *P. daphnoides* (q.v.) very closely, differing only in the darker pigmentation of the hairs (greyish to tawny in *P. daphnoides*), its less densely hairy tepals (moderately hairy in *P. daphnoides*), smaller flowers (tepals 9–10 mm long in *P. daphnoides*) and slightly fleshier leaves (venation usually evident on both surfaces in *P. daphnoides*). These species are probably sister-species, united by a synapomorphy of prostrate habit. Together they most closely resemble *P. oleoides*, differing from it in their prostrate habit and smaller flowers.

We had originally followed Bentham (1870) in including *P. procumbens* and *P. daphnoides* in *P. prostrata*, as subspecies C and B respectively, in Jacobs & Pickard (1981). The type specimen of *P. prostrata* (from Fraser Island, Queensland), however, differs from these two species in a number of characters, including its thicker stems, more coriaceous, larger, mostly elliptical leaves and densely hairy ovary (see also notes on *P. prostrata* and *P. stradbrokensis*, below).

P. procumbens occurs sympatrically with *P. oleoides* and *P. cornifolia* but appears not to hybridise with either species.

Selected specimens (17): New South Wales: Northern Tablelands: Pheasant Mtn, c. 2 km NE of Backwater, 30°04'S 151°53'E, *Telford 8984 & Butler*, 20 Jan 1983 (NSW ex CBG); Biscuit Creek, 7.5 miles [12 km] NW of Ebor [on Guyra road], *Ford* 10 Jan 1958 (NSW 43159); Snowy Range, 1 km SE of Cathedral Rock, Cathedral Rock National Park, 30°27'S 152°16'E, *Telford 10777*, 2 Jan 1989 (NSW ex CBG); 9.5 km SW of Ebor, on the Armidale – Grafton road, *Coveny 2278*, 5 Oct 1969 (NSW).

Persoonia rufa *L. Johnson & P. Weston*, **sp. nov.**

Pili ferruginei. Ramuli novelli modice vel dense pilosi. Folia elliptica vel late elliptica, 3–8 cm longa, 10–25 mm lata, subdiscoloria, scabra. Flores regulares. Tepala modice ad dense pilosi. Antherae flavae, sine appendice. Ovarium dense pilosum. Ovulum 1.

Holotype: New South Wales: Northern Tablelands: Gwydir Hwy, 4.3 km NE of turnoff to Raspberry Lookout, 29°32'S 152°17'E, *P.H. Weston 1428 & P.G. Richards*, 2 Jan 1990 (NSW). Isotypes: AD, BRI, CBG, K, MEL, MO, PERTH, RB.

[*P. cornifolia* subsp. C in Jacobs & Pickard (1981: 181)]

Erect to spreading shrubs, 1–2.5 m high. *Bark* smooth. *Hairs* of moderate length (0.1–1.2 mm long), tawny to ferruginous, appressed to patent. *Young branchlets* moderately to densely hairy; internodes 0–35(–55) mm long. *Leaves* alternate, elliptical to broad-elliptical, acuminate to mucronate, 3–8 cm long, 10–25 mm wide, flat, with recurved margins, sometimes slightly incurved, suberect, not falcate, twisted through 0–0.25 turns, not pungent, slightly discolorous, green, moderately hairy when immature, glabrescent to moderately so when mature, scabrous; venation brochidodromous, obscure to evident (more prominent on adaxial surface). *Inflorescences* axillary to terminal, anauxotelic (10–95%) or auxotelic (5–90%); auxotelic inflorescences 1–12-flowered, rachis 0–11 cm long, flowers mostly subtended by leaves; anauxotelic inflorescences 1–3(–6)-flowered, rachis 0–0.5(–1.5) cm long, flowers subtended by scale leaves. *Pedicels* 1–3 mm long, erect, moderately to densely hairy. *Tepals* 10–14 mm long,

caudate, moderately to densely hairy, yellow. *Anthers* yellow. *Ovary* densely hairy. *Ovule* 1. *Drupes* green or green with purple stripes. *Cotyledons* 4.

Derivation of epithet: Latin *rufus*, red or reddish, referring to the ferruginous hairs of the young branchlets.

Flowering period: December to February.

Habitat: Heath to dry sclerophyll eucalypt forest, on stony or sandy to loamy soils derived from granite.

Distribution: Restricted to the Gibraltar Range, north-eastern New South Wales (Figure 4).

Conservation Status: 2RCa.

Notes: *P. rufa* most closely resembles *P. cornifolia* and *P. oleoides*. It differs from the former species in the ferruginous colour of the hairs of the young branchlets and flowers, and its more strongly hairy-scabrous, more markedly discolorous leaves. It differs from *P. oleoides* in being a larger shrub, in its usually longer, more ferruginous hairs, its usually more scabrous leaves and its densely hairy ovary. Previously, one of us (LJ) had treated *P. rufa* as a subspecies of *P. cornifolia* (subsp. C in Jacobs & Pickard 1981). However, since *P. rufa* does not seem to intergrade with any other taxon, and the cladistic relationships in this group remain obscure, it seems more appropriate to name *P. rufa* at specific rank.

P. rufa does not grow with any other species of *Persoonia*.

Selected specimens (8): New South Wales: Northern Tablelands: southern end of Washpool State Forest, *Johnson & McGillivray 2426*, 20 Sep 1966 (NSW, AD, BRI, CBG, MEL); Mulligans Hut, Gibraltar Range National Park, *Coveny 2232*, 3 Oct 1969 (NSW, CBG); Gibraltar Range National Park, 62 km ENE of Glen Innes, 29°32′S 152°20′E, *Coveny 5685 & Lander*, 3 Oct 1974 (NSW, B, K, PERTH, RSA); Gwydir Hwy, 0.8 km E of Raspberry Lookout turnoff, Gibraltar Range National Park, 29°33′S 152°16′E, *Richards 103 & Weston*, 1 Feb 1988 (NSW).

Persoonia volcanica *P. Weston & L. Johnson*, **sp. nov.**

Frutices erecti 1.8–6 m alti. Cortex laevis. Pili adpressi vel plusminusve patentes. Ramuli novelli modice pilosi. Folia variantia: lineari-lanceolata, anguste lanceolata, lineari-elliptica, anguste elliptica, lineari-oblonga vel anguste oblonga, 4–9 cm longa, 5–10(–15) mm lata. Flores regulares. Tepala pilosiuscula. Antherae flavae, sine appendice. Ovarium glabrum.

Holotype: New South Wales: North Coast: Mt Lindesay Hwy, 12.0 km NE of Woodenbong, 28°20′S 152°40′E, *P.H. Weston 1353 & P.G. Richards*, 27 Jan 1989 (NSW). Isotypes: AD, BRI, CBG, K, MEL, MO, NSW, PERTH, RB.

Erect shrubs, 1.8–6 m high. *Bark* smooth. *Hairs* of short to moderate length (0.05-0.6 (–0.9) mm long), greyish to ferruginous, appressed to patent. *Young branchlets* moderately hairy; internodes (0–)2–20(–40) mm long. *Leaves* alternate, linearly to narrowly ovate to elliptical to oblong, acute to acuminate, 4–9 cm long, 5–10(–15) mm wide, flat, with recurved margins, spreading to suberect, not falcate or occasionally slightly falcate, not pungent, concolorous to strongly discolorous, green, sparsely to moderately hairy when immature, sparsely so to glabrescent when mature, smooth to slightly scaberulous; venation brochidodromous, obscure to faintly evident on both surfaces. *Inflorescences* axillary to terminal, usually auxotelic (rarely only 60%); auxotelic inflorescences 1–15(–20)-flowered, rachis 0–8(–18) cm long, flowers subtended by scale leaves or leaves; anauxotelic inflorescences 1–3-flowered, rachis 0–0.7 mm long, flowers subtended by scale leaves. *Pedicels* 1.5–5(–8) mm long, erect, moderately hairy.

Tepals 9–13 mm long, shortly caudate, moderately hairy, yellow. *Anthers* yellow. *Ovary* glabrous. *Ovule* 1. *Drupes* green.

DERIVATION OF EPITHET: Neo-Latin *volcanicus*, volcanic, from Latin *Volcanus*, the Roman god of fire, referring to the substrate on which the species usually occurs.

FLOWERING PERIOD: Mostly December to February, but sometimes as late as May.

HABITAT: Dry sclerophyll forest to rainforest margins in wet sclerophyll forest, usually on volcanic but sometimes on sedimentary substrates, at 500 to 1000 m altitude.

DISTRIBUTION: McPherson Range on the New South Wales – Queensland border and nearby mountains between Wilsons Peak and Levers Plateau (Figure 4).

CONSERVATION STATUS: 2RC-.

NOTES: This species has in the past been treated as a form, or unnamed infraspecific taxon, of *P. media* (see e.g. Stanley & Ross 1986, as *P. attenuata*). It differs from that species in its mostly antrorse to patent hairs, which generally occur more densely, its leaves, which are smaller on average, its usually shorter pedicels, and its bark, which is smooth to the base.

An unnamed *Persoonia* from Kroombit Tops, near Gladstone in central-eastern Queensland, closely resembles *P. volcanica*, and is probably its closest relative. Whether it should be named as a new species or as a subspecies of *P. volcanica* remains to be determined.

SELECTED SPECIMENS (9): QUEENSLAND: Moreton: just below summit of Mt Maroon, *Grimshaw*, 11 Sep 1989 (BRI, NSW); Mt Barney (lower slopes, track up S ridge), *Telford*, 17 May 1969 (NSW ex CBG); end of Tartars Creek Rd, at border fence, 28°19'S 152°51'E, *Weston 1356 & Richards*, 28 Jan 1989 (NSW). NEW SOUTH WALES: North Coast: Wilsons Peak, *Maiden*, Dec 1907 (NSW 20997); Mahoneys Spur, Levers Plateau, *Floyd 500*, 20 July 1977 (NSW); Mt Glennie, *Constable*, 8 Jan 1953 (NSW 22119, BRI).

Notes on reinstated names, names with changed circumscriptions, and some informal names listed in Jacobs & Pickard (1981)

Persoonia adenantha *Domin*
(Domin 1921: 582)

The taxa that one of us (LJ) previously treated as informal subspecies of *P. cornifolia* in Jacobs & Pickard (1981) are here treated as species. Although *P. adenantha* intergrades with *P. stradbrokensis* in the Casino area, it seems reasonable to recognise these taxa at specific rank because they are not necessarily sister species, and their precise relationships with other taxa such as *P. media* are obscure. This requires the reinstatement at specific rank of *P. adenantha* Domin, replacing the informal name *P. cornifolia* subsp. B.

Persoonia attenuata R. Br. (Brown 1830: 16) = **P. stradbrokensis** *Domin* x **P. virgata** *R. Br.?*

TYPE CITATION: 'Ora orient., Moreton Bay, 1827. *D. Fraser.*'

HOLOTYPE: Moreton Bay, *Fraser*, – (BM).

In Jacobs & Pickard (1981) the name *P. attenuata* was misapplied to the taxon that we are now calling *P. media* R. Br. Unfortunately, the holotype of *P. attenuata* has

immature fruits and no flowers, so a number of useful characters are lacking. Of the species that are closely related to *P. media*, it most nearly resembles *P. volcanica*, from which it differs in having comparatively thick, wrinkled leaves in which the lateral venation is obscure, smooth leaf surface, and leaf margins that are scarcely recurved except near the base of the leaf. It most closely matches the few specimens of *P. stradbrokensis* x *P. virgata* that we have seen, differing from them only in its narrowly to linearly ovate (versus linearly to narrowly oblong to elliptical) leaves.

Persoonia cornifolia *Cunn. ex R. Br.*
(Brown 1830: 16)

Type citation: 'Ora orient., Moreton Bay, 1827. *DD. Cunningham et Fraser.*'

Holotype: Lat 29 Long 150 ½ , *Cunningham 97*, June-July 1827 (BM).

Previously one of us (LJ) had treated this as a polymorphic species with four subspecies. Now we are narrowing its circumscription to that of *P. cornifolia* subsp. D (in Jacobs & Pickard 1981). *P. cornifolia* possibly intergrades with *P. stradbrokensis* in the upper Clarence River catchment. *P. cornifolia* differs from *P. stradbrokensis* in having completely smooth (rather than basally flaky) bark, in its predominantly anauxotelic inflorescences with short (0–0.3 cm) rachises, and its acute to apiculate (never caudate) tepals. Although some specimens of *P. stradbrokensis* from the Noosa–Cooloola area of Queensland have a high percentage of anauxotelic inflorescences, the rachises in these are mostly 0.5–2.0 cm long. See also the notes for *P. rufa* and *P. oleoides*.

Persoonia daphnoides *Cunn. ex R. Br.*
(Brown 1830: 15)

Type citation: 'Ora orient., prope Hunter's River, 1827. *D. Cunningham.*'

Lectotype (here designated): Western Branches of Hunter's River, *Cunningham 56*, – (BM). Probable isolectotypes: Bulga Road N from Port Jackson ... Mount Dangar, *Cunningham 56*, Aug 1827 (K); Hunters River, *Cunningham 59*, Aug 1827 (K, fragment NSW); also NY.

One of us (LJ) had earlier treated this species as *P. prostrata* subsp. B but, as noted above under *P. procumbens*, we now believe that *P. daphnoides* and *P. procumbens* are sister species and that they are not the closest relatives of *P. prostrata*.

The type location cited by Brown, and recorded on Allan Cunningham's labels, is undoubtedly erroneous as indicated by the following:

Firstly, all known populations of this taxon are restricted to the Tenterfield – Wilsons Downfall area of the Northern Tablelands of New South Wales and adjoining areas in Queensland (Figure 4), at altitudes of 1000 to 1200 m, on Permian adamellite. The type collection has neither flowers nor fruits, but the vegetative material is a good match for specimens from the Tenterfield area. One of us (LJ) has unsuccessfully searched the Mt Dangar area for this species.

Secondly, Cunningham ascended Mt Dangar on 22 April 1825, not in 1827 (E. Webster pers. comm.), so it is clear that his labels are at least partly inaccurate. In the winter of 1827 Cunningham collected in the interior, between the Liverpool Plains and Moreton Bay (E. Webster pers. comm.).

Thirdly, Cunningham supposedly collected other species from Mt Dangar that are otherwise known only from the Tenterfield–Stanthorpe area (W. McDonald pers. comm.). It seems most likely that Cunningham mistakenly transcribed the wrong

location details from his notebooks to the specimen labels for a whole batch of his specimens from the Tenterfield–Stanthorpe area, including those of *P. daphnoides*.

Persoonia lanceolata Andrews subsp. B = **P. glaucescens** *Sieber ex Sprengel*
(Sprengel 1827: 45)

TYPE CITATION: 'Sieb. ... *Nov. Holl.*'

SYNTYPE (*Sieber 47*): B.

Originally one of us (LJ) had thought that *P. lanceolata* Andrews and *P. glaucescens* Sieber ex Sprengel were allopatric taxa and had treated *P. glaucescens* as *P. lanceolata* subsp. B. Recent fieldwork by one of us (PW) has shown, however, that they occur sympatrically in the Hill Top – Balmoral area, without intergrading. Specific rank is thus appropriate for *P. glaucescens*.

Persoonia media *R. Br.*
(Brown 1830: 16)

TYPE CITATION: 'Ora orient., mont. prope Port Jackson, 1818. *D. Fraser.*'

HOLOTYPE: Oxley's 2nd Expedition, *Fraser 47*, – (BM).

[*P. attenuata* auct. non R. Br. in Jacobs & Pickard (1981), Stanley & Ross (1986)]

The name *P. attenuata* was previously misapplied to this species (see above) and so the name *P. media* (previously treated as a synonym of *P. attenuata*) must be reinstated. *P. media* occurs in New South Wales on the escarpment of the Northern Tableands from the northern Barrington Tops to Chaelundi Mountain and on the Nightcap Range and in south-eastern Queensland on the Lamington and Springbrook Plateaus. On the eastern edge of the Northern Tablelands between the Macleay and Manning Rivers, *P. media* seems to show clinal, intraspecific variability. This variation is ecologically correlated: on the driest sites (dry sclerophyll forest) the plants are usually multistemmed, lignotuberous, 0.3–2 m high, having short, anauxotelic inflorescences as well as, or instead of, auxotelic inflorescences. These specimens constitute *P. attenuata* subsp. B in Jacobs & Pickard (1981). Plants on the wettest sites (rainforest margins) are taller, (0.7–)2–8 m high, single-stemmed, produce only auxotelic inflorescences and on average have narrower leaves than the multi-stemmed plants. These specimens constitute, in part, *P. attenuata* subsp. A in Jacobs & Pickard (1981). In other characters these extreme forms resemble each other more closely than specimens from north of the Macleay (which were also included in subsp. A). Moreover, populations of *P. media* north of the Macleay show geographically correlated morphological variation, so the pattern of infraspecific variation is quite complicated. Consequently, we have chosen not to recogise any formal infraspecific taxa.

Persoonia prostrata *R. Br.*
(Brown 1810: 163)

TYPE CITATION: 'In Novae Hollandiae ora orientali; prope Sandy Cape'.

LECTOTYPE (here designated): Sandy Cape, Hervey's Bay, *R. Brown*, 31 July 1802 (BM).
ISOLECTOTYPE: NSW.

As discussed above, under *P. procumbens*, we are applying the name *P. prostrata* only to specimens from Fraser Island, in south-eastern Queensland.

P. prostrata is very similar to specimens of *P. stradbrokensis* collected from the mainland south of Fraser Island, but differs in its prostrate habit, usually smaller leaves

and smaller flowers. These differences are based on only two collections for *P. prostrata*, neither of which is an adequate specimen. It may be that *P. prostrata* and *P. stradbrokensis* are conspecific, and that *P. prostrata* is just a prostrate, maritime form. However, the distributions of these species are separated by over 100 kilometres and one of us (PW) has briefly traversed much of this intervening country without finding either species. If these taxa prove to be conspecific, there are unfortunate nomenclatural implications: *P. prostrata* (an inappropriate epithet for a combined taxon usually plants are erect shrubs to trees up to 8 m high) would have priority over *P. stradbrokensis*. It seems wisest to continue to recognise these entities as distinct taxa.

Recently, one of us (PW) failed to find *P. prostrata* despite searching the Bool Creek area, south-west of Sandy Cape, where Flinders and Brown landed in 1802. Brown (1810: 163) noted that he collected it 'prope Sandy Cape; in arenosis prope littora'. That *P. prostrata* does (or did) occur there is confirmed by the only other specimen, that collected by Miss S. Lovell, the school teacher at Sandy Cape during the late 19th and early 20th centuries. Apparently the northern end of Fraser Island is being eroded by the sea and it is possible that *P. prostrata* existed as a small population that is now extinct.

Persoonia stradbrokensis *Domin*
(Domin 1921: 580)

We are reinstating this name for the taxon that one of us (LJ) had informally named *P. cornifolia* subsp. A in Jacobs & Pickard (1981).

Persoonia sp. B (aff. *virgata*) = **P. cornifolia** *Cunn. ex R. Br.* x **P. tenuifolia** *R. Br.*, **P. sericea** *Cunn. ex R. Br.* x **P. tenuifolia** *R. Br.*, **P. stradbrokensis** *Domin* x **P. tenuifolia** *R. Br.*

The leaves of *P. tenuifolia* are so different from those of most other species of *Persoonia* (linear-filiform, 0.3–0.5 mm wide, terete and grooved on upper surface) that hybrids of it with relatively broad-leaved species do not resemble either parent closely. Consequently it is not surprising that such hybrids have been tentatively recognised as new taxa in the past. We have recently observed that *P. tenuifolia* apparently hybridises sporadically with *P. stradbrokensis*, where these taxa occur sympatrically at Kremnos Creek, south of Grafton. These hybrids are indistinguishable from specimens from the Grafton area that were attributed to *P.* sp. B. (aff. *virgata*). A few similar specimens, collected where *P. tenuifolia* is sympatric with *P. cornifolia* in the Torrington area, and with *P. sericea* in the Yetman area, presumably are also hybrids.

Persoonia sp. E = **P. cornifolia** *Cunn. ex R. Br.* x **P. fastigiata** *R. Br.*

Specimens that were attributed to *P.* sp. E are morphologically intermediate between *P. fastigiata* and *P. cornifolia*, and this prompted us to postulate that they were hybrids. One of us (PW) tested this idea by visiting a locality at which both presumed parents (but not *P.* sp. E) had been collected previously, Parlor Mountain. Both parents were re-collected there as well as plants attributable to *P.* sp. E that apparently formed part of a hybrid swarm.

Persoonia sp. F (aff. *oblongata*) = **P. levis** *(Cav.) Domin* x **P. oxycoccoides** *Sieber ex Sprengel*

This hybrid is represented by only four specimens, all from the Carrington Falls area. They are intermediate between the presumed parents in all respects except bark morphology; where noted, the bark was observed to be smooth and compact. Collectors have noted either that the hybrid was rare, or that they saw only one plant. One of

us (PW) has collected one specimen of this hybrid, where it was growing sympatrically with both parents as well as *P. mollis* subsp. *ledifolia* and *P. laurina* subsp. *leiogyna*.

Acknowledgements

We are most grateful to the following individuals for assisting with this project. Don Foreman, Siegfried Krauss and Karen Wilson critically read earlier drafts of the manuscript. Barbara Briggs and Merle Johnson assisted LJ at early stages of the project. Peter Richards, Siegfried Krauss and David Tomlinson accompanied PW on a number of field trips devoted to collecting Persoonias. Elsie Webster and Bill McDonald (BRI) provided unpublished information on Allan Cunningham's collections. Surrey Jacobs searched for type specimens of Persoon's species at Leiden, in his capacity as Australian Botanical Liaison Officer at Kew. Michael Crisp provided copies of some original descriptions. Peter Richards and Diane Godden drafted the maps. We are grateful to the Directors of the following institutions for giving us access to their collections as visiting workers or through loans of specimens: B, BM, BRI, K, M, MEL, NY, SYD.

References

Bentham, G. (1870) *Flora Australiensis*, vol. 5 (L. Reeve & Co.: London).

Briggs, B.G. & Johnson, L.A.S. (1979) Evolution in the Myrtaceae — evidence from inflorescence structure. *Proc. Linn. Soc. New South Wales* 102: 157–256.

Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants*. Australian National Parks & Wildlife Service Special Publication no. 14.

Brown, R. (1810) On the natural order of plants called Proteaceae. *Trans. Linn. Soc.* 10: 15–226.

Brown, R. (1830) *Supplementum primum prodromi florae Novae Hollandiae* (Richard Taylor: London).

Domin, K. (1921) Beiträge zur flora und pflanzengeographie Australiens, I. Teil. 3. Abteilung. Lieferung 1. *Bibliotheca Botanica* 89: 555–643.

Endlicher, S.L. (1848) *Genera plantarum supplementum quartum pars II*. (Friedrich Beck: Vienna).

Gandoger, M. (1919) Sertum plantum novarum. Pars secunda. *Bull. Soc. Bot. France* 66: 216–233, 286–307.

Hickey, L.J. (1973) Classification of the architecture of dicotyledonous leaves. *Amer. J.Bot.* 60: 17–33.

Jacobs, S.W.L. & Pickard, J. (1981) *Plants of New South Wales* (Govt Printer: Sydney).

Kuntze, O. (1891) *Revisio generum plantarum, part 2*. (Felix: Leipzig).

Meissner, C.D.F. (1855) New Proteaceae of Australia. *Hooker's J. Bot. Kew Gard. Misc.* 7: 65–78.

Meissner, C.D.F. (1856) Proteaceae. Pp. 209–482 in A. de Candolle (ed.), *Prodromus systematis naturalis regni vegetabilis*, vol. 14 (Victor Masson: Paris).

Persoon, C.H. (1805) *Synopsis plantarum* 1 (C.F. Cramer: Paris & J.C. Cotta: Tübingen).

Schultes, J.A. & Schultes, J.A. (1827) *Mantissa systematis vegetabilium* 3 (J.C. Cotta: Stuttgart).

Smith, J.E. (1805–1808) *Exotic Botany* 2 (R. Taylor and Co.: London).

Sprengel, C. (1827) *Systema vegetabilium* Editio Decima Sexta, 4(2) Curae Posteriores (Librariae Dieterichianae: Gottingen).

Stanley, T.D. & Ross, E.M. (1986) *Flora of south-eastern Queensland*, Vol. 2 (Queensland Department of Primary Industries: Brisbane).

Weston, P.H. (1983) *The systematics and biogeography of the Persooniinae (Proteaceae)* (unpublished Ph.D. thesis, University of Sydney).

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Almaleea, a new genus of Fabaceae from south-eastern Australia

Michael D. Crisp and Peter H. Weston

Abstract

Crisp, Michael D.[1] and Weston, Peter H.[2] ([1] Division of Botany and Zoology, Australian National University, GPO Box 4, Canberra ACT 2601, formerly Australian National Botanic Gardens, GPO Box 1777, Canberra ACT 2601 Australia; [2]National Herbarium of New South Wales, Royal Botanic Gardens, Sydney NSW 2000 Australia) 1991. Almaleea, *a new genus of Fabaceae from south-eastern Australia.* Telopea *4(2): 307-311.* The new genus described herein was identified in an earlier cladistic analysis of genera in the tribe Mirbelieae. It includes species formerly placed in *Pultenaea* and *Dillwynia*, and is closely related to *Dillwynia* and *Eutaxia*. Combinations are made for the five known species, which occur in Tasmania, Victoria and eastern New South Wales. A fuller account of the species will appear in the Flora of New South Wales.

Introduction

The genus described here includes species formerly placed in *Pultenaea* and *Dillwynia*. Thompson (1961) placed these in a subgroup of *Pultenaea* distinguished by minute stipules and hooked styles. Crisp and Weston (1987) included these species (as the '*Pultenaea incurvata* group', separated from *Pultenaea* sensu stricto) in a cladistic analysis of genera in the tribe Mirbelieae. Their results showed that *Almaleea* is more closely related to *Dillwynia* than to *Pultenaea*. It was included in a clade with *Eutaxia, Dillwynia, Latrobea* and *Pultenaea neurocalyx* (the last also analysed separately from *Pultenaea*). Synapomorphies for this clade were: wings longer than the keel and a hooked style (both reversed in *Latrobea*). *Almaleea* was placed as sister-group to the other four taxa. Subsequently, one of us has re-analysed *Pultenaea* and closely related genera (MC, unpublished), using additional characters and including *Pultenaea selaginoides*, a taxon that was omitted from our earlier analysis. Using successive weighting, a single most parsimonious cladogram was produced that included the following clade (internal relationships indicated by parentheses): *Latrobea*, (*Pultenaea selaginoides*, ((*Almaleea*, *Dillwynia*), (*Eutaxia*, *Pultenaea neurocalyx*))). This clade is united by two characters: leaves concave or paler adaxially, and leaves more or less keeled abaxially. *Eutaxia, Dillwynia, Pultenaea neurocalyx* and *Almaleea* form a clade united by the wings being shorter than the keel. Because it was structurally correlated with the short keel, the hooked style character was excluded from this analysis.

All five taxa can be readily diagnosed by autapomorphies (uniquely derived characters shared by their species). *Latrobea* has a calyx with equal lobes and the standard is peaked. *Pultenaea selaginoides* has caducous, scale-like bracts. *Almaleea* has distinctive bracts forming an involucre at the base of the inflorescence. *Dillwynia* is distinguished by its subterete (often triquetrous) leaves with an adaxial groove, its standard-lamina, which is broader than long and reniform or bilobed, and its wing apices, which are enlarged and downcurved. *Eutaxia* has decussate leaves. *Pultenaea neurocalyx* has ciliate leaf margins.

Besides lacking the characters which define the above clade, *Pultenaea* differs from all the taxa in it, including *Almaleea*, in having unique, conspicuous stipules which have scarious margins and which are united behind the petiole.

This brief account of *Almaleea* is needed to provide names for the Flora of New South Wales. We intend to publish a full treatment of the genus in the near future.

The following key distinguishes all the genera listed in the '*Pultenaea* group' by Crisp and Weston (1987: Table 8), except that the 'genus aff. *Aotus*' also includes the *Oxylobium microphyllum* group and *Pultenaea selaginoides* has been separated from *Pultenaea* as a result of the more recent cladistic analysis.

Key to Genera Related to *Pultenaea*

1 Stipules conspicuous, united behind the petiole, margins scarious ..... **Pultenaea**
1* Stipules minute, free, without scarious margins
  2 Bracteoles absent; leaves in whorls of 3 or more, often irregularly .. **Aotus**
  2* Bracteoles present; leaves spirally arranged or decussate
    3 Leaves concave or paler on the adaxial (upper) surface, or terete to triquetrous and longitudinally grooved above
      4 Leaves 3-nerved on abaxial (lower) surface; calyx with 5 or 10 ribs
        5 Leaves decussate, lacking ciliate margins; calyx not prominently ribbed ..... **Eutaxia**
        5* Leaves arranged spirally, margins ciliate; calyx prominently ribbed ..... **Pultenaea neurocalyx**
      4* Leaves not 3-nerved abaxially; calyx not ribbed
        6 Calyx with uniform teeth or lobes; standard peaked; pod compressed, triangular; aril neither channelled longitudinally nor papillate ..... **Latrobea**
        6* Calyx with upper two lobes broader and united higher than lower three; standard rounded or emarginate at apex; pod turgid, more or less ovoid; aril channelled longitudinally and papillate
          7 Inflorescence an anauxotelic head surrounded by an involucre of leaves progressively modified into bracts by enlargement of the stipular base; bracts persistent ..... **Almaleea**
          7* Inflorescence various; if head-like, then lacking an involucre; bracts usually deciduous
            8 Style abruptly hooked upwards at the tip; wing petals distinctly longer than keel; standard-lamina reniform or bilobed; leaves terete or triquetrous with a longitudinal adaxial groove (except *D. ramosissima* may be broadly channelled adaxially) ... **Dillwynia**
            8* Style gently curved; wing petals equal to or slightly longer than keel; standard-lamina ± orbicular; leaves concave, not terete or triqetrous ..... **Pultenaea selaginoides**
    3* Leaves with recurved margins, or if flat then darker on the adaxial surface
      9 Leaves flat; style longitudinally winged ..... **Urodon**
      9* Leaves with recurved to revolute margins; style not winged
        10 Calyx with upper two lobes enlarged and rounded, lower three lobes vestigial; hairs peltate ..... **Euchilopsis**
        10* Calyx not as above; hairs not peltate

11 Keel beaked, lobed on the upper margin only; pod glabrous inside ..... **Phyllota**

11* Keel rounded at apex, lobed asymmetrically on both upper and lower margins; pod pubescent inside ..... Genus aff. **Aotus**

Almaleea *Crisp & P. Weston*, **gen. nov.**

Frutices exiles, paludes incolentes; foliis alternis, simplicibus, superne concavis, inferne plerumque lineam rubiginosam vel badiam instructis; stipulis minutis liberis; floribus in capitulum terminale aggregatis, foliorum basibus in bracteas saepe trilobas successive amplificatis involucro cinctis; bracteis fructu persistentibus; bracteolis in pedicello affixis; floribus papilionaceis, vexillo longiore quam latiore, aliis quam carina longioribus; staminibus liberis; ovario pubescenti, stylo compresso apice uncinato, stigmate terminali capitato, ovulis 2; legumine turgido ovoideo; semino triangulari, testa laevi, arillo papillato longitudinaliter canaliculato.

TYPE: *Almaleea incurvata* (Cunn.) Crisp & P. Weston

Erect to procumbent shrubs or subshrubs. Leaves arranged spirally, simple, margins entire, upper surface flat or concave, lower surface usually with a dull reddish or brownish central streak; stipules minute, free; petiole very short, pulvinate. Inflorescence a terminal head surrounded by an involucre of leaves with stipular bases progressively enlarged into bracts; outer bracts often 3-lobed with modified lamina and stipules; bracts persistent in fruit; bracteoles entire, linear, attached to the pedicel. Corolla orange-yellow with reddish markings; standard longer than lower petals, slightly longer than wide; wing petals longer than keel. Stamens free. Ovary hairy to base; style compressed and hooked at apex; stigma terminal, capitate; ovules 2, on short funicles. Pod turgid, more or less ovoid; seeds triangular, smooth with papillose aril.

5 species in freshwater bogs along the east coast of Australia from far north-eastern New South Wales to Tasmania.

ETYMOLOGY: We have named this genus in honour of the late Mrs Alma Lee (née Melvaine), a botanist with a long and distinguished career at the National Herbarium of New South Wales. We wish to highlight her contributions to systematics of the Fabaceae, especially her critical insights into relationships in the tribe Bossiaeeae.

Key to Species

1 Standard c. 6 mm long; leaf-margins flat, tuberculate, ciliate when immature ..... **A. paludosa**

1* Standard > 6 mm long; leaf-margins slightly incurved to involute, smooth and glabrous or whole abaxial leaf surface tuberculate and sparsely pubescent when immature

2 Branchlets moderately to densely covered with antrorse to spreading hairs; bracteoles 3-5 mm long; leaves towards end of stems with incurved apices ..... **A. incurvata**

2* Branchlets glabrous to densely covered with appressed to antrorse hairs; bracteoles 1-2.5 mm long; leaves not incurved

3 Leaves glabrous or rarely pubescent when young, not tuberculate, with flat to slightly incurved or rarely involute margins; lower part of calyx-tube glabrous or nearly so; outer bracts broad-ovate to orbicular ..... **A. subumbellata**

3* Leaves usually pubescent abaxially when young, usually tuberculate abaxially, with moderately incurved to involute margins; lower part of calyx tube hairy; outer bracts narrow-ovate to ovate
4 Calyx tube sparsely pubescent and lobes moderately so (calyx epidermis clearly visible beneath) ..... **A. capitata**
4* Calyx densely villous (calyx epidermis scarcely visible beneath) ..... **A. cambagei**

Almaleea paludosa *(J. Thompson) Crisp & P. Weston*, **comb. nov.**

BASIONYM: *Pultenaea paludosa* J. Thompson, Proc. Linn. Soc. New South Wales 83: 188 (1958).

HOLOTYPE: NEW SOUTH WALES: Swamps between Coogee and Bondi, *E. Betche*, 16 September 1886 (NSW 38185, photo CBG).

DISTRIBUTION: Coast from the Grafton district, North Coast of New South Wales, to eastern Gippsland, Victoria.

Almaleea incurvata *(Cunn.) Crisp & P. Weston*, **comb. nov.**

BASIONYM: *Pultenaea incurvata* Cunn. in Field, Geogr. Mem. : 346 (1825).

TYPE CITATION: 'Margins of peaty bogs. Kings Table Land'. LECTOTYPE (here designated): NEW SOUTH WALES: Peaty bogs, Kings Tableland, *A. C[unningham]* (K: Herbarium Hookerianum, 1867, 'negative no. Kew 1039'). ISOLECTOTYPES: BM, CGE (2 sheets), K (2 sheets), W. Photos CBG.

DISTRIBUTION: Blue Mountains, near Sydney, New South Wales.

Almaleea subumbellata *(Hook.) Crisp & P. Weston*, **comb. nov.**

BASIONYM: *Pultenaea subumbellata* Hook., Bot. Mag. 60: t. 3254 (1833).

TYPE CITATION: '...Glasgow Botanic Garden is indebted to Dr. Scott, who sent seeds from Van Diemen's Land, from which plants were raised that blossomed in April, 1833'. LECTOTYPE (here chosen): plate 3254 (no specimen is extant).

SYNONYM: *Pultenaea subumbellata* var. *alpina* Hook. f., Fl. Tasmaniae 1: 87 (1856).

TYPE CITATION: 'Gunn 319. On the Western and other mountains, ascending to 4000 feet...'. SYNTYPES: Tasmania: K (2 sheets with several specimens from Herbarium Hookerianum, annotated in pencil: *'P subumbellata* Hook. var. *beta'*). ISOSYNTYPES: BM, CGE (2 sheets), K (1 sheet), NY. Photos CBG.

DISTRIBUTION: Mostly in mountainous regions, up to 1500 m altitude, in Tasmania, Victoria east from the Grampians Ranges and Portland district, and Southern Tablelands of New South Wales south from Big Badja Mountain.

NOTES: This is a variable species, and one variety has been described, from subalpine altitudes. Further investigation is needed to determine whether infraspecific taxa should be recognised.

Almaleea capitata *(J.H. Willis) Crisp & P. Weston*, **comb. nov.**

BASIONYM: *Dillwynia capitata* J.H. Willis, Victorian Naturalist 73: 192 (1957).

HOLOTYPE: NORTH-EAST VICTORIA: near Clover Dam, between Tawonga and Bogong townships, at Cranky Charlie's Turntable on the SEC mountain road, *J. Galbraith*, 4 November 1949 (MEL 627545). Photo CBG. ISOTYPE: NSW (2 sheets).

SYNONYM: *Dillwynia capitata* var. *uliginosa* J.H. Willis, Muelleria 1: 124 (1967).

HOLOTYPE: VICTORIA: On boggy ground at c. 3600 feet [1080 m], near Black Mountain Station, Wulgulmerang, far eastern Victoria, *K.C. Rogers*, 9 December 1962 (MEL 627543, partly). ISOTYPES: MEL 627543 (partly), MEL 627544, Photos CBG, NSW.

DISTRIBUTION: Subalpine areas in the Southern Tablelands of New South Wales, south from Namadgi National Park and the eastern highlands of Victoria east from the Wonnangatta Valley.

NOTES: The identity of this taxon has been problematic, owing to the poor quality of the type material. Despite several searches at the type locality, nobody, including the original collector and one of us (MC), has been able to re-locate it there. However, other populations closely resembling the holotype have been found in the same region, e.g. in the Wonnangatta Valley (*E. Chesterfield 2587*, CBG, MEL) and at Rocky Plains near Mt Wombargo (*M. Crisp 8092a-g*, CBG, NSW, MEL).

When J.H. Willis described *Dillwynia capitata* var. *uliginosa*, only three specimens of *A. capitata* had been collected. Subsequent collections indicate that the types of the varieties represented the extremes of variation in leaf length and that the varieties are not distinct taxa.

Almaleea cambagei *(Maiden & Betche) Crisp & P. Weston*, **comb. nov.**

BASIONYM: *Pultenaea cambagei* Maiden & Betche, Proc. Linn. Soc. New South Wales 33: 308 (1908).

TYPE CITATION: 'Torrington, Deepwater, Nova Anglica (in paludibus, R.H. Cambage; September mensis MDCCCCVII)'. LECTOTYPE (here designated): NEW SOUTH WALES: In swamps or damp flats, Torrington, *R. H. Cambage 1621A*, 29 September 1907 (NSW 38177). ISOLECTOTYPES: BM, K, MEL. Photos CBG.

SYNONYM: *Pultenaea subumbellata* var. *cambagei* H. Williamson, Proc. Roy. Soc. Victoria 33: 145 (1921).

DISTRIBUTION: Northern Tablelands of New South Wales in the Torrington area and also in the headwaters of the Henry River.

Acknowledgements

We thank Evan Chesterfield for collecting *A. capitata* from the Wonnangatta Valley; Joan Taylor and Ian Telford for assistance; and the heads of the HO and MEL herbaria for the loan of specimens.

References

Crisp, M.D. and Weston, P.H. (1987). Cladistics and legume systematics with an analysis of the Bossiaeeae, Brongniartieae and Mirbelieae. In C.H. Stirton (ed.), *Advances in Legume Systematics*, part 3: 65-130. (Royal Botanic Gardens, Kew).

Thompson, J. (1961). *Papilionaceae.* Contributions from the New South Wales National Herbarium. Flora Series 101(1): 1-91.

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Two new species of *Astrotricha* (Araliaceae) from New South Wales

R.O. Makinson

Abstract

Makinson, R.O. (National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW, Australia 2000) 1991. Two new species of Astrotricha *(Araliaceae) from New South Wales.* Telopea *(4)2: 313–319. A. roddii* and *A. obovata* are described and illustrated, with notes on distribution, ecology, conservation status and similar species.

Introduction

Astrotricha is a mesophyllous to sclerophyllous shrub genus, with ten named and recognised species, all but one endemic to south-eastern Australia (the exception being a Western Australian endemic, *A. hamptonii*). The genus is currently under revision by Makinson and M. Henwood, University of Sydney, and the number of recognised species is expected to rise to about 16. Two new names are published here, with notes and illustrations, to make them available for Flora treatments. Both taxa have been studied in the field by the author. Descriptions are based on field notes and herbarium specimens, including spirit and rehydrated material.

Astrotricha roddii *R. Makinson*, **sp. nov.**

Folia 10–18 cm longa, acuta, anguste elliptica vel anguste ovata, petioli ≤ 2 cm longi. Inflorescentiae purpuratae trichomatibus albidis; flores glabripetali; mericarpia trilocellata.

Holotype: New South Wales: North Western Slopes: Macintyre Falls, 3 km S of junction of Macintyre and Severn Rivers, *A.N. Rodd 4096*, 23 Nov 1984 (NSW 198521). Isotypes: BRI, MEL.

Erect weakly woody shrub 1.5–2.5(–3.5) m high, unbranched or with 2–4 ascending branches from c. ½ height, habit sympodial; vegetative stems light green (not empurpled) beneath the hairs; stems with a dense firmly floccose indumentum of stellate hairs, indumentum of stems and leaves made up of stellate hairs of c. 0.5–0.7 mm diam., those of the flowering axes smaller, c. 0.3–0.4 mm diam. *Leaves* with densely hairy petioles 10–15(–20) mm long; restricted to recent growth, alternate, spreading, somewhat convex adaxially, lamina narrowly elliptical to narrowly ovate, (9–)11–18 cm long, 10–25(–28) mm wide; apex acute to very long-acute; base rounded to broadly cuneate; upper surface on very young leaves with stellate hairs, on mature leaves glabrous, usually rather glossy, all veins evident and recessed, otherwise smooth (lacking asperities); lower surface with a dense thick greenish white indumentum, the midvein and main lateral veins evident; margin shortly recurved. *Inflorescence* a terminal panicle, erect, up to 40 cm long, with 3–5 orders of branching, branches numerous and ascending, subtended by bracts (the lowermost sometimes foliose), inflorescence axes usually deep purple beneath the persistent open whitish indumentum; secondary peduncles 1–2 cm long, bracteate; ultimate bracteoles narrowly ovate to oblong-subulate, 0.8–2.0 mm long at anthesis, usually slightly longer in fruiting stage, 0.3–0.5 mm wide, green to brownish purple, outer surface with an

open indumentum, inner surface glabrous. *Buds* ridged along the petal sutures. *Flowers* protandrous; *pedicels* usually 2–4 mm long on flowers, to c. 6 mm in fruit, with an open to dense indumentum; hypanthium hairy but with some surface tissue visible, 1.0–1.5 mm long in male stage, elongating to 1.5–3.0 mm long in female stage; *sepals* 5, minute, more or less triangular, 0.3–0.6 mm long, hairy outside, persistent on fruit; *petals* 5, glabrous, incurved to erect in male stage, spreading to strongly reflexed in female stage, oblong-triangular, 2.6–2.8 mm long, 0.7–1.5 mm wide, purple, not persistent on young fruit. *Stamens* 5, alternate, soon falling; anthers whitish in bud becoming pale purple before dehiscence, 1.5–2.0 mm long; pollen yellow; filament attached slightly below the medial position. *Styles* purplish, connate and c. 1 mm long and enclosed during male stage, elongating to c. 2 mm long in female stage and diverging, persistent and robust and arching strongly outwards in fruiting stage. *Fruit* a tardily or non-dehiscent dry schizocarp, ellipsoid to slightly obovoid and usually slightly laterally compressed, usually with rounded longitudinal ridges, 4.5–5 mm long, 3–4 mm wide, surmounted by the persistent styles and inconspicuous erect calyx lobes, often a few persistent hairs about the apex; mericarps internally three-chambered, the central (seed) chamber flanked by two partially pith-filled locelli. *Seed* wedge-shaped in cross section, slightly arcuate in face view, 3–4 mm long. Figure 1.

The species is named for Anthony Norman Rodd (1940 –), botanist, who collected the species in 1984 at the Macintyre Falls site; the epithet is given also in grateful acknowledgement of the encouragement and assistance that Tony Rodd has always given to newer workers in botany.

Distribution: The species is known from only three sites N of Inverell in the North Western Slopes botanical district of N.S.W. The largest population, of a few hundred plants, occurs at Macintyre Falls, about 25 km (direct) NNW of Ashford; a second, much more sparse population occurs a few kilometres to the south-east along the Severn River. A third population has recently been found at Pindari Reservoir, 20 km SE of Ashford. A nineteenth century collection (*Lau*, MEL 119649) is annotated 'New England QL', suggesting the possibility of collection on the Queensland side of the border.

Habitat and ecology: All three sites bear a mixed dry woodland of *Callitris endlicheri* and *Eucalyptus* spp. (ironbarks) around granite or (at Pindari) porphyry exposures.

The relatively undisturbed sites at Macintyre Falls (400 m altitude) and Pindari Reservoir (600 m) have a fairly rich sclerophyllous shrub understorey. Establishment and survival of *A. roddii*, like some other *Astrotricha* species, is likely to be strongly affected by the density of surrounding understorey vegetation and degree of canopy shading; in this case a semi-open canopy and shrub layer seem to be favoured. The species also has an extremely vigorous taproot and favours crevices or areas of rock rubble for establishment; it is largely absent from nearby areas of level ground.

The exact size and extent of the Macintyre Falls population remain to be determined, but it certainly comprises more than 200 plants. Field observations in 1988 and 1989 show that seedlings are able to establish in the absence of fire. Some plants flower at only about 1.5 m high, probably at about 18 months old; a longevity of about 3–8 years seems likely from the degree of branching observed.

A smaller population of the species, about 4.5 km upstream from the confluence of the Severn and Macintyre Rivers, is on freehold land. It is of uncertain extent, and of very low density — 18 plants were found along about 1 km of riverbank, mostly next to or among rock exposures and boulders. The site is subject to grazing and fire, and undergrowth is very sparse.

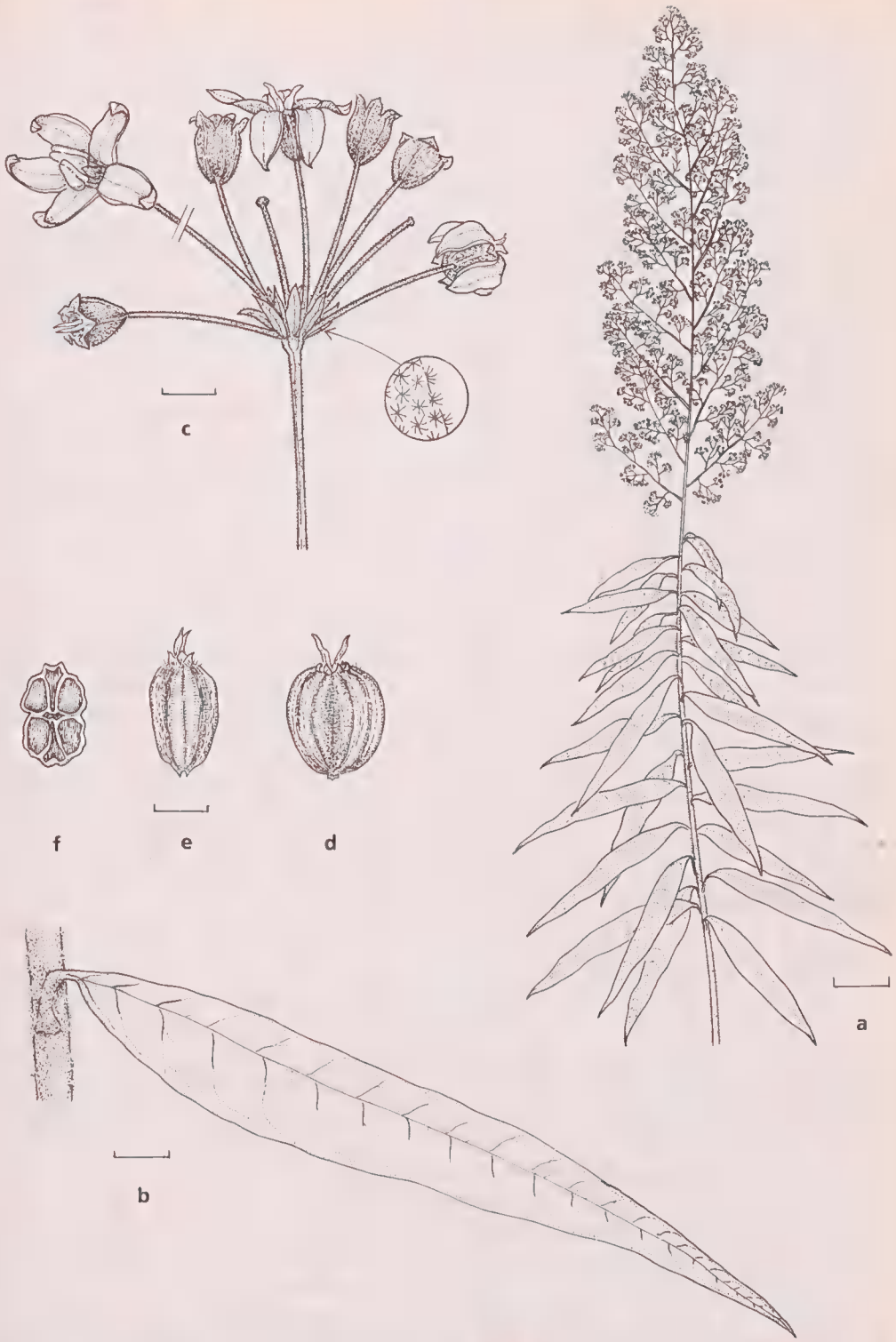

Figure 1. *Astrotricha roddii*. **a,** flowering branch, scale 20 mm. **b,** leaf, adaxial surface, scale 10 mm. **c,** umbel (inset showing stellate hairs), scale 2.5 mm. **d, e,** fruit, face and edge views respectively, scale 2.5 mm. **f,** fruit, transverse medial section to show trilocellate mericarps. (a, b from holotype; d–f from *Makinson* 567).

The third known population occurs on the upper slopes of a hill known as The Barbs just south of Pindari Reservoir. Thirty-one plants were found during a search in October 1990, scattered in small groups or singly. Numerous other hills and ridges in the area are likely to provide suitable habitat. The species' occurrence at this site on a porphyrytic substrate, and on granite elsewhere, suggests a potential (albeit sporadic) geographic range covering much of the North West Slopes region.

Conservation status: The Macintyre Falls population is largely contained within an Inverell Shire Council Flora and Fauna Reserve, from which stock are excluded by fences and grids. Land-use at the Pindari Reservoir site is controlled by the Water Resources Commission. The species seems potentially vulnerable to changes in fire frequency and grazing regime. Pending searches for further populations, a conservation coding of 2RC or 2EC is suggested, in accordance with the criteria given in Briggs & Leigh (1988); see summary of codes at back of issue.

Plants at the type locality suffered heavily from casual vandalism in late 1989. Of 200 plants counted in early December, 140 (70%) were flowering adults; of these, 40 had been deliberately broken at about half height, i.e. a total of 20% of all plants and roughly one-third of all adult plants. Some trampling of adults and juveniles had also occurred. It seems likely that the damage was caused by children, which may have implications for management of the problem. The Reserve is likely to be subject to increasing visitation as a local tourist attraction.

Similar taxa: The affinities of *A. roddii* are as yet unclear. There is a superficial resemblance to *A. floccosa* (a Sydney Basin endemic with cream flowers), to *A. longifolia* (cream flowers and smaller leaves), and *A. biddulphiana* (purple flowers but much less hairy, and with smaller leaves and stature). The 3-chambered mericarp of *A. roddii* is apparently unique in the genus, although the pith-filled locelli may prove to be homologous with the schizocarp wings of the *A. pterocarpa* complex.

Selected specimens: New South Wales: North Western Slopes: Macintyre Falls Reserve, 29° 10′ S, 150°57′ E, *Makinson 567 & Krauss*, 20 Oct 1988 (NSW 222280 – 2 sheets, BRI), *Makinson 601*, 11 Dec 1989 (NSW 226601, CANB, MEL); 22 km (direct) NNW of Ashford, Severn R. 1.5 km upstream of Severn Falls, *Makinson 602*, 12 Dec 1989 (NSW 226602, CBG, CHR, K); upper slopes of The Barbs, just S of Pindari Reservoir, *Makinson 639 & Coveny*, 8 Oct 1990 (NSW). Locality uncertain: New England QL, *H. Lau*, – (MEL 119649, ?P).

A. obovata *R. Makinson*, **sp. nov.**

Folia obovata vel raro oblonga, 1–3 cm longa, prope marginem asperata. Inflorescentiae breves, pauciflorae; petala cum staminibus cadentia.

Holotype: New South Wales: Central Coast: Colo Heights to Putty Road at mile peg 50 miles [80 km] north of Windsor ... rocky ridge on right hand side of road going north, *E.F. Constable s.n.*, 23 Nov 1959 (NSW 228124, CANB, MEL). [The material here designated as type, clearly relatable to a single rootstock, has been separated from a large multi-plant collection registered as *NSW 220544*; the balance of the gathering, under that number, is excluded from type status].

Erect slender or compact bushy shrub 0.3–1.0 m high, often several-stemmed from, or below, ground level, resprouting from upper rootstock after damage. Most of plant clad with a close, firm, dense (non-floccose) indumentum of stellate hairs, the hairs usually 0.2–0.4 mm diam. on vegetative parts, those on flowering axes 0.1–0.3 mm diam. *Leaves* ascending, flat or shallowly V-shaped in transverse section, with densely hairy petioles 1–3 mm long; lamina usually oblong-obovate to obovate or occasionally narrow-oblong or narrow-oblong-elliptical, 1–3 cm long, 3.5-10 mm wide; apex obtuse or occasionally slightly emarginate; base cuneate to rounded; upper surface glabrous

(except on very young leaves), matt to glossy, with the midvein only faintly evident as a channel, usually with few to many widely-spaced (sometimes inconspicuous or absent) peak-like obtuse to acute asperities 0.1–0.2 mm high on or near margin (sometimes giving the leaf a denticulate appearance), or rarely scattered over whole upper surface; lower surface with a dense close greyish to pale gold indumentum, the midvein barely evident in relief; margin slightly recurved to flat. *Inflorescences* terminal, weakly erect, very loose, sometimes inconspicuous, 1–6 cm long, simple or few-branched with 1–5(–7) umbellate clusters of flowers, each cluster with (1–)2–4(–5) flowers; secondary peduncles 10–15 mm long, bracteate; ultimate bracteoles narrow-triangular, 0.5–1.9 mm long, 0.3–0.5 mm wide, hairy outside, glabrous inside. *Flowers* protandrous; *pedicels* 1–5 mm long, elongating to c. 7.5 mm long in female and fruiting stages, densely hairy; hypanthium c. 1.5 mm long in male stage, becoming 2.0–2.3 mm long and urceolate in female stage; *sepals* 5, more or less triangular, 0.2–0.6 mm long; *petals* 5, suberect to reflexed, soon falling, oblong-ovate to subtriangular, 1.9–2.2 mm long, 0.9–1.4 mm wide, densely hairy outside, greenish yellow and glabrous inside. *Stamens* 5, alternate, falling early; anthers cream, 1.5–1.8 mm long; filaments attached at or just below the medial position. *Styles* in late bud and male stage straight and narrowly divergent, 1.0–1.2 mm long, elongating to c. 1.6 mm long in female stage and becoming strongly curved outwards. *Fruit* a tardily dehiscent, laterally compressed schizocarp, 4.2–4.5 mm long, c. 4.7 mm wide, 1.8 mm thick, surmounted by the persistent styles and by a 'crown' formed of the calyx lobes connate into a ring at their bases; surface of the mericarps with knobbly longitudinal ridges, mericarps single-chambered. Figure 2.

The epithet is from the Latin *obovatus*, obovate, referring to the typical shape of the leaves, distinctive within the genus.

Variation: A few specimens have all leaves narrow-oblong or narrow-oblong-elliptical, e.g. *Benson & Bryant* (NSW 220532); *Burgess* (NSW 220537). These collections have scarcely any asperities on the upper (adaxial) leaf surface. The collection *Blakely* (NSW 220533) also has rather narrow subelliptical leaves, but has typical peaked asperities atypically distributed across the whole upper surface (denser in, but not confined to, the marginal one or two millimetres). These specimens are respectively from the northern, southern, and eastern extremities of the known range. Instances of asperities scattered all over the upper surface also occur sporadically in populations with the typical obovate leaf form, e.g. *Beesley 195* (CBG, NSW).

Distribution and conservation status: Found in the northern part of the Central Coast botanical division of New South Wales, in a dissected sandstone plateau area bounded on the south by the Hawkesbury River, on the west by the Colo and Capertee Rivers, and in the north by the Hunter Valley. Single records are known from adjacent parts of the Central Tablelands division (near Glen Davis), and North Coast division (Weston, near Cessnock). The species is well represented in Dharug, Wollemi and Yengo National Parks, and does not appear to be under any threat.

Habitat and ecology: The species occurs on shallow sandy soils on sandstone, in dry sclerophyll woodland or forest with a shrubby understorey, at 250–660 m altitude. Associated species often include *Angophora euryphylla*, *A. bakeri* subsp. *bakeri*, *Eucalyptus fibrosa* subsp. *fibrosa*, *E. punctata*, *E. oblonga*, *Grevillea mucronulata*, *G. buxifolia* subsp. *buxifolia*, *Persoonia levis*, *Xylomelum pyriforme* and *Lambertia formosa*.

A. obovata is fairly tolerant of physical and fire disturbance and is probably semi-successional following fire episodes. It may also be found on or near road verges and old gravel quarries. The coppicing habit has been seen at various sites; in some cases the triggering factor seems to have been damage caused by fire, in others by physical disturbance. New stems sprout from near the root/stem junction, just below ground

Figure 2. *Astrotricha obovata*. **a,** flowering branch, scale bar 10 mm. **b,** leaf, adaxial surface, scale bar 2 mm. **c,** flower, male stage, scale bar 2 mm. **d,** flower, female stage, scale bar 2 mm. **e, f,** fruit, face and edge views respectively, scale bar 2 mm. **g,** fruit, transverse medial section, scale bar 2 mm. (a-c from *Beesley 195*, d-g from *Henderson & Rodd 2705*).

level; this zone may be quite thick (about 12 mm diam.), but tapers gradually into the lower root. Whether this thickened zone is a true (stem-derived) lignotuber is undetermined, but the mode of regrowth is similar. Remote suckers (from far-spreading roots) have not yet been confirmed.

FLOWERING: occurs in (at least) November and December, and is not as tightly synchronous on a plant as is usual in most species of *Astrotricha*; it is not unusual to find very young buds, open flowers, and fruits on one plant.

SIMILAR SPECIES: *A. obovata* most nearly resembles, and is perhaps most closely related to, *A. ledifolia* DC. The latter name is often erratically applied, but properly refers to a taxon confined to the Central and Southern Tablelands of N.S.W. and montane regions of far north-eastern Victoria. *A. ledifolia* has obtuse oblong (not obovate) leaves, the upper surfaces of which bear many fine asperities (< 0.1 mm high) scattered over the whole leaf surface; only occasionally are the asperities either larger than this and strongly acute, or confined to the submarginal area. *A. ledifolia* also has a much more conspicuous, elaborated and floriferous inflorescence (usually 6–15 cm long), with numerous spreading branches, secondary peduncles to 4 cm long, and petals usually persistent to the fruiting stage. Both species can commonly regenerate from the base, which is unusual in the genus; *A. ledifolia* can have remote suckers from a laterally-wandering root. The geographical range of *A. ledifolia* approaches that of *A. obovata* in the area north of Lithgow; there is a disjunction of about 45 km between the nearest known occurrences of the two species. The actual disjunction (to judge by available habitat) is probably less. Nevertheless, they are separated by the Capertee and Colo Rivers and by an altitudinal difference of about 300–400 m. No morphologically intermediate collections are known.

SELECTED SPECIMENS: NEW SOUTH WALES: North Coast: c. 2 km directly NNE of Weston, near Cessnock, *Benson & Bryant*, 2 Dec 1981 (NSW 220532). Central Coast: Colo Heights to Putty road, at mile peg 50 miles [80 km] N of Windsor, *Constable*, 23 Nov 1959 (NSW 220544, AD, BRI, CANB, CHR, DNA, E, G, HO, K, L, MEL, MO, P, PERTH, UNE, plus further duplicates to be distributed); Putty Road, Howes Valley, c. 1.5 km NW of Howes Mtn, *Bishop, Goodwin & James 604*, 13 Nov 1984 (NSW 220542, AD, BRI, CANB, MEL); Bucketty, 33°07′ S 151°08′ E, *Henderson & Rodd 2705*, 19 Nov 1974 (NSW 220536, BRI, K, MO); Mogo Creek, N of St Albans, *Burgess*, 16 Oct 1961 (NSW 220537); Kulnura, *Blakely*, May 1937 (NSW 220533); 23 km from Yarramalong along Brush Creek towards 'The Letter A', *Beesley 195 et al.*, 21 Nov 1984 (CBG 8411582, NSW). Central Tablelands: 4 miles [6.4 km] by road NE of Gospers [Uraterer] Mtn, alt. 660 m, *Rodd & Coveny 294*, 7 Jul 1968 (NSW 102028).

Acknowledgements

Thanks go to Felicity Green for the illustrations, to Peter G. Wilson for assistance with the Latin descriptions, and to Murray Henwood, Jocelyn Powell and Lawrie Johnson for comments.

Reference

Briggs, J.D. & J.H. Leigh (1988). *Rare or threatened Australian plants*. Australian National Parks & Wildlife Service Special Publication no. 14.

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Systematic studies in the eucalypts – 4

New taxa in *Eucalyptus* (Myrtaceae)

K.D. Hill & L.A.S. Johnson

Abstract

Hill K.D. & Johnson L.A.S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. Systematic studies in the eucalypts – 4. New taxa in Eucalyptus *(Myrtaceae).* Telopea 4(2): 321–349. A number of new taxa are described: *Eucalyptus gigantangion, E. pachycalyx* subsp. *waajensis, E. eucentrica, E. kabiana, E. beaniana, E. granitica, E. atrata, E. persistens* (with subspecies *tardecidens*), *E. sicilifolia, E. suffulgens, E. dura, E. reducta, E. mensalis* and *E. microcodon.*

Introduction

Over past decades, increased activity and interest in eucalypt taxonomy has revealed a large number of undescribed taxa. This paper is one of a series of contributions towards an overall revision of the eucalypts, validating names of new taxa for use in forthcoming regional treatments. Taxa treated here are predominantly from Queensland, with some from Central Australia and the Northern Territory.

At this stage, *Eucalyptus* L'Hérit. will be used in the traditional sense. The species are not allocated alphabetic codes according to the system of Pryor & Johnson (1971) since these are being revised. Species are treated in the order in which they occur in the revised classification developed from Pryor & Johnson.

Rare or threatened species are allocated conservation status codes according to the system of Briggs & Leigh (1988); see summary of codes at back of issue.

We are acquainted with all the new and related taxa in the field.

Terminology

The term 'stemonophore' is used throughout as a more acceptable combination of Greek elements than the Latin–Greek hybrid 'staminophore' (after Johnson & Briggs 1984).

The term 'calyptra' is used throughout as in Johnson & Briggs in place of 'operculum'. The latter term has been traditionally used in *Eucalyptus* alone, whereas the former is the accepted term for the fused perianth structures occurring widely in Myrtaceae (Johnson & Briggs 1984, following McVaugh 1968).

The calyptra in all *Monocalyptus* taxa is described as 'appearing single' in reference to the actually complex nature and origin of this structure, to be discussed elsewhere.

The hairs on juvenile leaves of stringybark taxa are described as 'stellate hairs' for brevity. These are not stellate hairs as occurring in for example certain Chenopodiaceae, but are distinctive structures in which a number of simple hairs arise from a raised oil gland (discussed by Johnson (1972) and Ladiges (1984)).

Bark is described as 'persistent' in cases where it is not regularly shed, and 'smooth' when regularly shedding. The former includes 'stringybark', 'box' and 'ironbark' among other types, and the latter covers the 'gum' barks.

Species authorship is to be cited as presented under each taxon described. They are not cases for the use of 'ex'.

1. Eucalyptus gigantangion *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. miniata* distinguitur: folia adulta angustiora, alabastra costata et non glauca, fructus maximi.

TYPE: NORTHERN TERRITORY: Twin Falls, Kakadu National Park (13°18'S 132°51'E), *C. Dunlop 6722 & G. Wightman*, 16 July 1984 (holo NSW; iso DNA).

Tree to 12 m tall. *Bark* persistent on trunk, fibrous with included scales, dark red-brown; smooth on branches, white or grey-white. *Adult leaves* disjunct, bright green, discolorous, linear to lanceolate, 8–14 cm long, 9–20 mm wide; petioles 9–15 mm long; lateral veins distinct, regularly pinnate, moderately spaced, at 50°–60° to midrib; reticulum irregular; intramarginal vein distinct, within 0.5 mm of margin. *Inflorescences* simple, axillary; umbellasters 7–flowered; peduncles basally thickened, 15–30 mm long, to 7 mm diam., 15 mm diam. at base. *Buds* ovate to broadly fusiform, sessile, ribbed, 25–30 mm long, 10–14 mm diam.; calyptra convex-conical, ± apiculate, ½ – ⅔ as long as hypanthium. *Stamens* bright orange, all fertile; filaments regularly inflexed in bud; anthers oblong, dorsifixed, dehiscing by parallel slits. *Fruits* urceolate, ribbed, 3-locular, 45–70 mm long, 35–50 mm diam.; calyptra scar and stemonophore raised, 2–3 mm wide; disc steeply depressed, 10–15 mm wide; valves deeply enclosed. Figure 1.

Distinguished from *E. miniata* A. Cunn. ex Schauer by the narrow adult leaves (lanceolate to broad-lanceolate in the latter), the ribbed, non-glaucous buds, and the large fruits (to 50 mm long, 40 mm diam. in the latter).

DISTRIBUTION: Known only from the Arnhem Land escarpment, now largely in Kakadu National Park (Figure 2).

ECOLOGY: Locally frequent but restricted to skeletal sands on broken siliceous sandstone around the immediate upper edge of the Kombolgie Formation sandstone cliffs that form the Arnhem Land escarpment. A distinctive form of *E. miniata* with grotesquely ribbed and strongly glaucous buds occurs on the footslopes of the same cliffs and around their bases.

The epithet is derived from the Greek *gigas, gigantos*, a giant, and *aggeion* (usually transliterated as *angion*), a vessel or receptacle, from the extremely large fruits.

CONSERVATION STATUS: Locally abundant over a considerable area; not considered to be at risk.

SPECIMENS EXAMINED: NORTHERN TERRITORY: 41 miles [65.6 km] from Pine Creek towards UDP Falls, *Gittins 2716*, Aug 1973 (NSW); Deaf Adder Gorge, Kakadu National Park, *Boland 2143, 2155 & Wardman*, 18 Nov 1984 (CANB, NSW).

2. Eucalyptus pachycalyx *Maiden & Blakely*, Maiden & Blakely, Crit. Revis. Eucalyptus 8: 15, pl. 289, fig. 12 (1929)

TYPE CITATION: 'A kind of Spotted Gum growing on the ranges at the back of Cairns, Qld. Stunted tree, bluish bark with black spots (H.W. Mocatta, No. 13, December, 1915). This is the only locality known to us.'

TYPE: holo NSW.

Tree to 10 m high. *Bark* smooth, glossy, mottled, pink, grey, yellow, orange, varying with season. *Juvenile leaves* opposite or later disjunct, petiolate, broad-lanceolate, to 15 cm long, 5.5 cm wide. *Adult leaves* disjunct, lanceolate, acuminate, falcate, dull, 5–15 cm long, 10–22 mm wide; petioles terete, grooved above, 10–25 mm long; lateral veins at c. 45° to midrib, moderately spaced, branching, densely reticulate between; intramarginal vein distinct, 0.5–1.0 mm from margin. *Umbellasters* axillary, often paired by accessory branching, 11- or sometimes 7-flowered; peduncles terete, 6–16 mm long; pedicels terete, 2–5 mm long. *Mature buds* ovoid to subglobular, 6–10 mm long, 4–5 mm diam.; calyptra hemispherical, ± as long as hypanthium. *Stamens* all fertile;

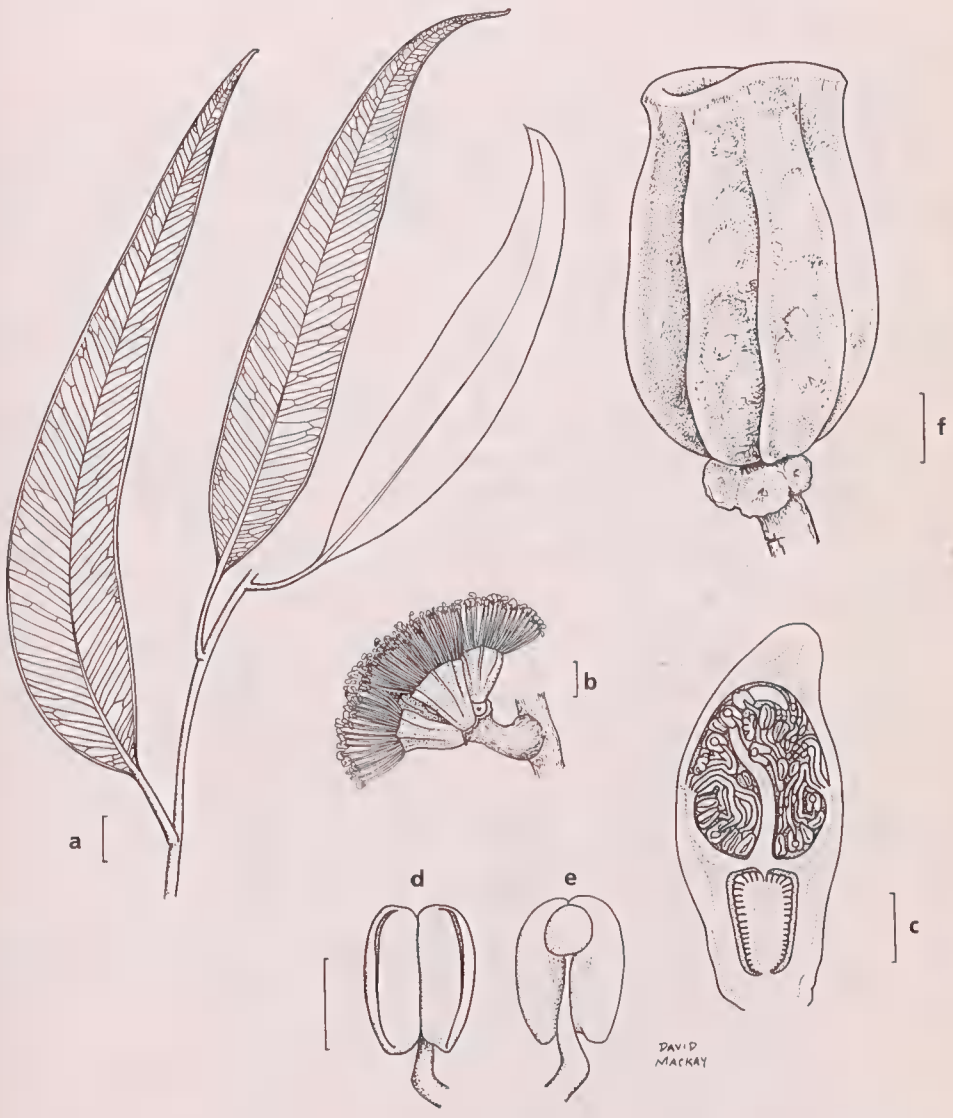

Figure 1. *Eucalyptus gigantangion*. **a**, adult leaves; **b**, flowers; **c**, median section of bud; **d**, **e**, anther; **f**, fruit (all from *Dunlop 6722 & Wightman*). Scale bar: a, b, f = 1 cm; c = 5 mm; d, e = 0.1 mm.

filaments inflexed in bud; anthers basifixed, versatile, globular, dehiscing through lateral pores. *Fruits* hemispherical or cup-shaped, 3–4-locular, 5–6 mm long, 6–8 mm diam.; calyptra scar and stemonophore distinct, flat, c. 1 mm wide (each c. 0.5 mm wide); disc c. 1 mm wide, sharply depressed; valves deeply enclosed basally, acuminate, tips vertically exserted, remnants of persistent style forming tips of valves.

Two subspecies are recognised.

Key to the subspecies

1 Calyptra conical; peduncles 6–14 mm long;, pedicels 2–4 mm long ..... **2A.** subsp. **pachycalyx**

1* Calyptra hemispherical; peduncles 12–16 mm long; pedicels 4–5 mm long ..... **2B.** subsp. **waajensis**

2A. Eucalyptus pachycalyx *Maiden & Blakely* subsp. **pachycalyx**

Adult leaves 10–15 cm long, 13–20 mm wide; petioles 13–20 mm long. Peduncles terete, 6–14 mm long; pedicels terete, 2–4 mm long. Mature buds ovoid to subglobular, 7–10 mm long, 4–5 mm diam.; calyptra conical, ± 1.5 times as long as hypanthium. Fruits hemispherical or cup-shaped, 3–4-locular, 5–6 mm long, 7–8 mm diam.

DISTRIBUTION: restricted to a zone along the west of the Atherton Tableland. Figure 3.

ECOLOGY: Locally abundant in low dry sclerophyll woodland on sandy soils over sandstones, acid volcanics and siliceous granites in hilly country.

SELECTED SPECIMENS (from 25 examined): QUEENSLAND: Mount Mulligan, *Clarkson 5876*, 16 Apr 1985 (BRI, CANB, MEL, NSW, PERTH, QRS); c. 18 km S of Mutchilba on road to Stannary Hills, *Rodd 4503 & Hardie*, 21 Apr 1985 (NSW, BRI, CANB); in rocky hills near Bakerville, *Brooker 3359*, 25 Jan 1972 (CANB, NSW); west of the road from Ravenshoe to Koombooloomba Dam, *Clarkson 2674*, 11 Oct 1979 (BRI, K, NSW).

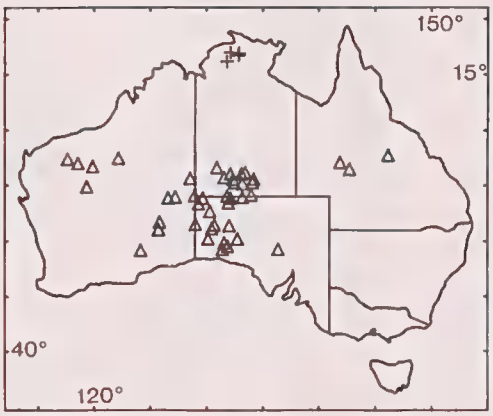

Figure 2. Distribution of *E. gigantangion* (+) and *E. eucentrica* (△).

2B. Eucalyptus pachycalyx *Maiden & Blakely* subsp. **waajensis** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie *pachycalyci* distinguitur: calyptra hemisphaerica, pedunculi pedicellique longiores, fructus saepe triloculares.

TYPE: QUEENSLAND: Waaje, NW corner of Barakula State Forest (26°09'S, 150°21'E), *A. Bean 19*, 9 Apr 1983 (holo NSW).

Adult leaves 5–12 cm long, 10–22 mm wide; petioles 10–25 mm long. Peduncles terete, 12–16 mm long; pedicels terete, 4–5 mm long. Mature buds ovoid to subglobular, 6–7 mm long, 4–5 mm diam.; calyptra hemispherical, ± as long as hypanthium. Fruits hemispherical or cup-shaped, 3–locular, 5–6 mm long, 6–7 mm diam. Figure 3.

Figure 3. *E. pachycalyx* subsp. *waajensis*. **a,** adult leaves and buds; **b,** juvenile leaves; **c,** median section of bud; **d, e,** anther; **f,** fruits (all from *Bean 19*). Scale bar: a, b = 1 cm; c = 2 mm; d, e = 0.5 mm; f = 5 mm.

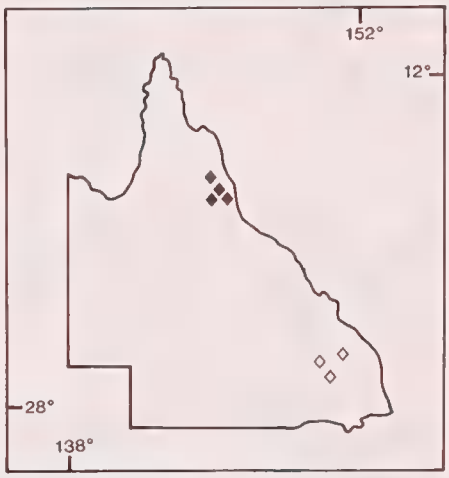

Figure 4. Distribution of *Eucalyptus pachycalyx* subsp. *pachycalyx* (◆) and subsp. *waajensis* (◇).

Distinguished from subsp. *pachycalyx* by the hemispherical calyptra and the relatively long peduncles and pedicels. Fruits are often 3-locular (more frequently 4-locular in the latter).

DISTRIBUTION: Known from scattered populations in southern Queensland, at Waaje in the Barakula State Forest, east of Tambo, and near Eidsvold (Figure 4).

ECOLOGY: Found in open woodland on shallow sandy soil over sandstone, on low ridges. Associated with *E. bloxsomei* Maiden, *E. watsoniana* F. Muell., *E. trachyphloia* F. Muell., *E. sideroxylon* A. Cunn. ex Woolls, and *E. tenuipes* (Maiden & Blakely) Blakely.

The subspecific epithet refers to the first known occurrence of this species at Waaje in the Barakula State Forest, near Barakula.

CONSERVATION STATUS: 2V. Occurs in small relict populations that are not in reserved areas.

SELECTED SPECIMENS (from 5 examined): QUEENSLAND: 24.3 km from Cracow on Nathan Gorge road, *Blaxell 89/238 & Johnson*, 10 Aug 1989 (NSW); Panda Lane, Compartment 28, Barakula State Forest, *Wallace 83032*, 19 Aug 1983 (NSW).

3. Eucalyptus eucentrica *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. sociali* distinguitur: folia adulta majora, alabastra fructusque majores et filamenta staminum flavescentia.

TYPE: NORTHERN TERRITORY: 39.4 km N of Erldunda on Stuart Highway (24°52'S 133°11'E), *K. Hill 858, L. Johnson & D. Benson*, 10 July 1984 (holo NSW; iso BRI, CANB, DNA).

Erect mallee. *Bark* persistent on lower trunk, shortly fibrous-flaky, smooth above, grey. Juvenile leaves disjunct, petiolate, broad-lanceolate to ovate. *Adult leaves* disjunct, lanceolate to broad-lanceolate, dull grey-green, 6–13 cm long, 14–34 mm wide; petioles 16–30 mm long. *Inflorescences* simple, axillary; umbellasters 7–13-flowered; peduncles terete or angular, 5–14 mm long; pedicels terete, 2–6 mm long. *Buds* fusiform, glaucous, 10–18 mm long, 4–5 mm diam.; calyptra elongate-conical, rostrate, 1½ – 2½ times longer than hypanthium. *Stamens* all fertile, yellow; filaments irregularly flexed and inflexed in bud, anthers basifixed, sub-versatile,

globular, dehiscing through lateral pores. *Fruits* globular to cylindrical, glaucous, 3–4-locular, 5–9 mm long, 5–9 mm diam., stemonophore and calyptra scars level, less than 0.5 mm wide; disc vertically depressed; valves basally enclosed, apically vertically exserted with subulate tips of persistent style. Figure 5.

Distinguished from *E. socialis* F. Muell. ex Miq. by the larger adult leaves (to 9 cm long in the latter), the larger buds (to 13 mm long in the latter) and the larger fruits (to 6 X 6 mm in the latter), and the yellow flowers (cream in the latter). *E. yumbarrana* Boomsma from southern South Australia is similar in flower colour, but coarser again in leaves (to 14 cm long), buds (5–7 mm diam.) and fruits (to 12 mm long).

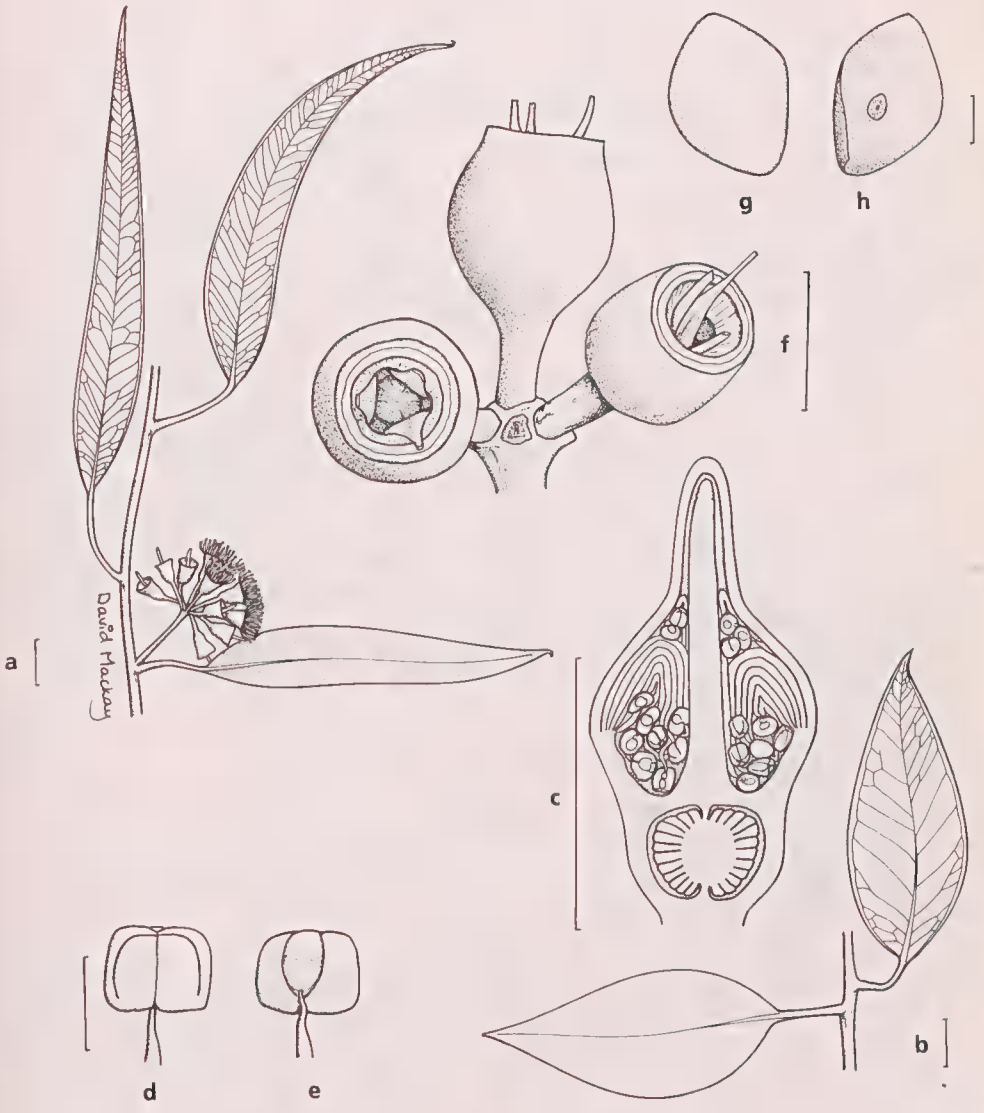

Figure 5. *E. eucentrica*. **a,** adult leaves and flowers; **b,** juvenile leaves; **c,** median section of bud; **d, e,** anther; **f,** fruits; **g, h,** seed (all from *Chippendale & Johnson NT 3971*). Scale bar: a, b = 1 cm; c, f = 5 mm; d, e, g, h = 0.5 mm.

Distribution: Sporadic and locally abundant over a wide area in Central Australia (N.T., S.A. and W.A.), with isolated outlying populations in the Pilbara region of W.A. and in central Queensland (Figure 4).

Ecology: A locally abundant species on a wide range of sites and substrates. Often on red sand with a calcareous horizon, in swale areas in dune systems, or on stony slopes, again with calcareous deposits in the soil.

Intergrading populations occur with *E. yumbarrana* (widespread from near Ooldea to the northwestern Eyre Peninsula). These in turn intergrade in a contact zone with *E. socialis* further east in northern Eyre Peninsula.

The epithet is from the Greek *eu-*, well, and *kentrikos*, of the centre, referring to the species' wide occurrence in the interior regions of Australia. An epithet earlier used by us in determining specimens is now pre-occupied by the name *E. centralis* applied to a bloodwood by Carr & Carr (1985).

Conservation status: Locally abundant over a wide area; not considered to be at risk.

Selected specimens (from 98 examined): Queensland: 5.4 km NE of Shuttleworth bore, 'Lou Lou Park' Station (22°15'S 146°09'E), *Hill 1183 & Johnson*, 21 Aug 1984 (NSW, BRI, CANB, DNA, MEL). Northern Territory: 40 miles [64 km] E of Alice Springs, *Forde 61*, 21 Jan 1956 (CANB, NSW); Corroboree Rock, E of Alice Springs, *Nelson 1820*, 4 Jan 1969 (DNA, NSW); 45.6 miles [72 km] WSW of Finke townsite, *Chippendale & Johnson*, 14 Oct 1957 (DNA [NT 3971], NSW); Alice Springs, at back of dump, *Brooker 5367*, 9 Oct 1976 (CANB, NSW); road into Serpentine Gorge, *Leach 528*, 24 Feb 1985 (DNA, NSW, CANB); near Nulcharra Creek, 19 km E of 'Mulga Park' Station, *Hill 851, Johnson & Benson*, 10 July 1984 (NSW); Red Bank Gorge, *Beauglehole 10509*, 9 July 1965 (AD, NSW, CANB). South Australia: 6.3 km S of NT–SA border on Stuart Highway, *Hill 848, Johnson & Benson*, 9 July 1984 (NSW, AD, CANB, PERTH); Vokes Hill junction (28°34'S 130°41'E), *Symon 12372*, 21 Aug 1980 (AD, CANB, NSW, PERTH); eastern end of Champ de Mars, Tomkinson Range (29°09'S 129°06'E), *Barker 3269*, 5 May 1978 (AD, NSW); Serpentine Lakes (28°31'S 129°01'E), *Donner 7427*, 25 Aug 1980 (AD, NSW); 50 miles [80km] NW of Pimba, *Martin*, July 1951 (NSW); Ooldea, *Donner 7559*, 31 Aug 1980 (AD, NSW); 17 km N of Watson towards Maralinga, *Brooker 5599*, 31 Mar 1977 (CANB, NSW). Western Australia: Lake Hopkins area (24°22'S 128°33'E), *Henry 409*, 9 Apr 1972 (DNA, NSW); 74 km E of Warburton, *Brooker 9219*, 4 Apr 1986 (CANB, NSW); Neale Junction, *Brooker 8561*, 12 May 1984 (CANB, NSW); just S of Rudall River (22°34'S 122°11'E), *George 10800*, 22 May 1971 (PERTH, NSW); 54.3 km S of Kumarina roadhouse on Great Northern Highway, *Hill 502, Johnson, Blaxell & Brooker*, 2 Nov 1983 (NSW, CANB, PERTH); top of Mt Meharry, *Hill 482, Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983 (NSW, CANB, PERTH).

4. Eucalyptus kabiana *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. tereticorni* distinguitur: habitus multicaulis, pedunculi pedicellique breviores, calyptra brevior, folia adulta juveniliaque plerumque minora, umbellastra 11-flora.

Type: Queensland: lower N slope of Mt Beerwah (26°54'S, 152°53'E), *K. Hill 1247, L. Johnson & A. Bean*, 26 Aug 1984 (holo NSW; iso BRI, CANB, MEL).

Mallee to 5 m high, usually less, rarely a small tree to 10 m high. *Bark* smooth throughout, whitish to light grey, glossy; sometimes with a short fibrous stocking in larger plants. *Seedling leaves* opposite for 4–6 nodes, oblanceolate, petiolate. *Juvenile leaves* disjunct, lanceolate to broad-lanceolate, dull grey, petiolate. *Young stems* quadrangular. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, falcate, acuminate, 6–12 cm long, 8–16 mm wide; petioles 11–20 mm long, terete or ± angular; lateral veins moderately spaced, irregular, at 30–50° to midrib; reticulum open, degenerate; intramarginal vein continuous, distinct, 1.0–1.5 mm from margin. *Inflorescences* simple, axillary; umbellasters 7–11-flowered; peduncles terete, 5–14 mm long; pedicels terete or ± ribbed, 2–4 mm long. *Mature buds* cylindrical-fusiform, 10–

12 mm long, 3–4 mm diam.; calyptra elongate conical, convex, acute, 3–4 times longer than hypanthium. *Stamens* all fertile; filaments erect in bud; anthers elliptical, dorsifixed, versatile, dehiscing by parallel slits. *Fruits* hemispherical, 3–4-locular, 4–5 mm long, 5–7 mm diam.; calyptra scar raised at c. 45°, continuous with stemonophore, the two c. 0.5 mm wide combined; disc raised at c. 45°, ultimately flattened, 1.5–2.5 mm wide; valves broadly triangular, apiculate, strongly exserted, raised at c. 90°, tips

Figure 6. *E. kabiana*. **a,** adult leaves, buds and flowers; **b,** median section of bud; **c, d,** anther; e, fruits; **f, g,** seed (a, e, f, g from Bean 4; b, c, d from *Bean* 5). Scale bar: a, e = 1 cm; b = 5 mm; c, d, f, g = 0.5 mm.

slightly incurved. *Seeds* semi-glossy, charcoal black, angular, cuboid or pyramidal with dentate fringes, deeply loosely reticulate, c. 1.0 mm long; hilum ventral; chaff red-brown, semi-glossy. Figure 6.

E. kabiana differs from *E. tereticornis* Sm. in the frequently 11-flowered umbellasters (7-flowered in the latter), the mallee habit, the 'stocking' of rough bark in older but still small plants, the shorter peduncles and pedicels (to 25 mm and 10 mm long respectively in the latter), the shorter calyptra and the generally smaller adult and juvenile leaves (to 20 cm long in the latter) and narrower juvenile leaves (ovate in the latter).

DISTRIBUTION: Glasshouse Mountains, in the Moreton District of Queensland (Figure 7).

ECOLOGY: Known only from two mountain peaks (Mt Beerwah and Mt Coolum), occurring on skeletal soils over steep trachyte slopes, often in mallee-heath with *Leptospermum luehmannii*, or in low woodland with *Lophostemon confertus*.

The specific epithet commemorates the Kabi Aboriginal people, who originally inhabited the Glasshouse Mountains region.

CONSERVATION STATUS: 2VC. Known only from two small populations.

SELECTED SPECIMENS (from 8 examined): QUEENSLAND: N slopes of Mt Beerwah (26°54'S, 152°53'E), *Bean 4*, 6 Sep 1980 (NSW); N slopes of Mt Beerwah (26°54'S, 152°53'E), *Bean 5, 6*, 9 Sep 1983 (NSW); N slope of Mt Beerwah, *Brooker 8269*, 5 Aug 1983 (CANB, NSW, BRI).

5. Eucalyptus beaniana *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. decorticanti* distinguitur: alabastra minora, fructus minores angustioresque, cortex persistens usque ad ramos minores.

TYPE: QUEENSLAND: Isla Gorge Lookout, to W of carpark (25°12'S, 149°58'E), *K. Hill 1231, L. Johnson & A. Bean*, 24 Aug 1984 (holo NSW; iso BRI, FRI, K, MEL, PERTH).

Tree to 10 m tall. *Bark* persistent to smaller branches, hard, black 'ironbark'; smooth, brownish white on branches < 5 cm diam. *Adult leaves* disjunct, similifacial, narrow-lanceolate to lanceolate, acute or acuminate, 7–13 cm long, 9–23 mm wide; petioles to 17 mm long; lateral veins moderately spaced, regular, at 40°–50° to midrib; reticulum

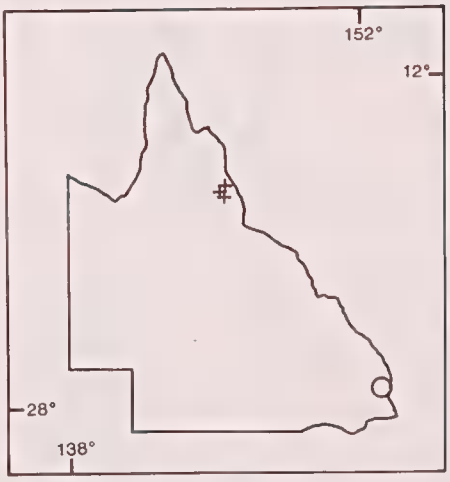

Figure 7. Distribution of *E. kabiana* (○) and *E. atrata* (+).

even; oil glands small; intramarginal vein continuous, distinct, 0.2–0.5 mm from margin. *Inflorescences* simple or compound, terminal or axillary; umbellasters 7-flowered; peduncles ± 2-winged, 5–11 mm long; pedicels ± angular, thick, 1–3 mm long, tapering into buds or fruits. *Mature buds* elongate-ovoid, 6–7 mm long, 2–3 mm diam.; calyptra conical, convex, as long as hypanthium or slightly shorter. *Fruits* obconical, 4–5-locular, 4–6 mm long, 3–5 mm diam.; calyptra scar and stemonophore continuous, flat, 0.2–0.4 mm wide; disc narrow, initially raised, ultimately incurved, 0.3–0.6 mm wide; valves broadly triangular, obtuse, basally slightly enclosed, apically exsert-

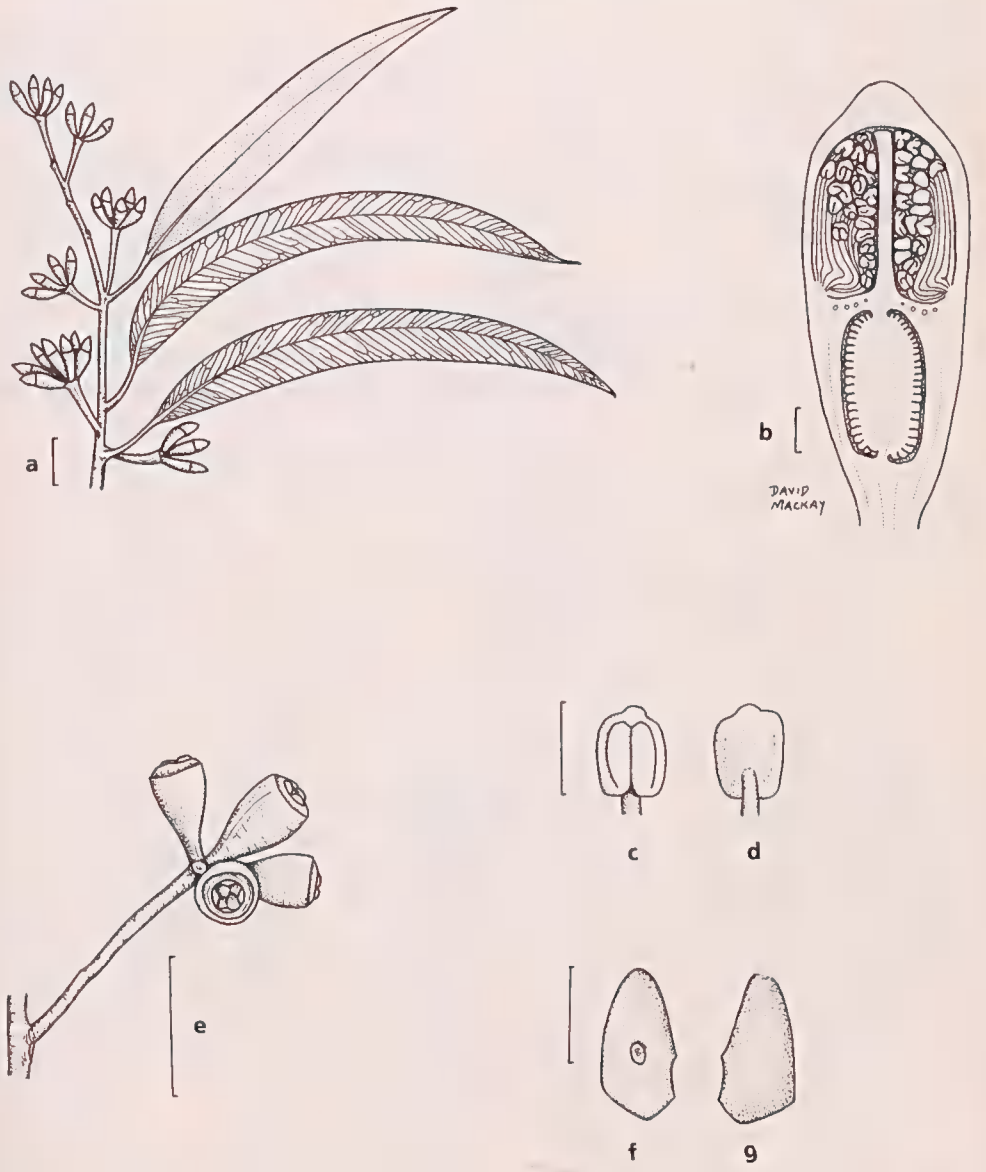

Figure 8. *E. beaniana*. **a**, adult leaves and buds; **b**, median section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (all from *Hill 1231, Johnson & Bean*). Scale bar: a, e = 1 cm; b, f, g = 1 mm; c, d = 0.5 mm.

ed, raised at c. 45°. *Seeds* semi-glossy, red-brown, rounded, elliptical, almost smooth; hilum ventral; chaff red-brown. Figure 8.

E. beaniana is distinguished from *E. decorticans* Maiden by the smaller buds (3–5 mm diam. in *E. decorticans*), the smaller and narrower fruits (5–7 mm diam. in *E. decorticans*), and the more extensive rough bark.

DISTRIBUTION: Isla Gorge area, north of Taroom, Queensland (Figure 9).

ECOLOGY: Known only from cliff tops around Isla Gorge. Locally frequent in woodland on skeletal sandy soil on sandstone, associated with *E. suffulgens* L. Johnson & K. Hill, *E. watsoniana* F. Muell., *E. trachyphloia* F. Muell., *E. tenuipes* (Maiden & Blakely) Blakely and *E. cloeziana* F. Muell.

The epithet honours naturalist Anthony Bean of Nambour, whose industrious investigations in the field have thrown much light on the distribution of Queensland eucalypts and other plants.

CONSERVATION STATUS: 2VC. Known only from the type population.

SELECTED SPECIMENS (from 5 examined): QUEENSLAND: Isla Gorge, c. 1 km S of lookout, *Blaxell 1538 & Armstrong*, 3 Sep 1977 (NSW, BRI, CANB); Isla Gorge lookout, *Boyland 8022*, 11 Sep 1979 (BRI, CANB, NSW).

6. Eucalyptus granitica *L. Johnson & K. Hill*, **sp. nov.**

Inter species *Crebrarum* combinatione characterum sequentium distinguitur: folia juvenilia nitentia lanceolata subsessilia disjunctaque, folia adulta nitentia late lanceolata.

TYPE: QUEENSLAND: 11.8 km from Atherton on Herberton road, (17°20'S, 145°25'W), *J.R. Clarkson 5706*, 3 Feb 1985 (holo NSW; iso AD, BRI, DNA, FRI, K, MEL, MO, PERTH, PRE, QRS).

Tree to 20 m high, often less. *Bark* persistent throughout or to smaller branches, soft or hard, 'corky' ironbark. *Juvenile leaves* disjunct, glossy, subsessile, lanceolate, to 2.5

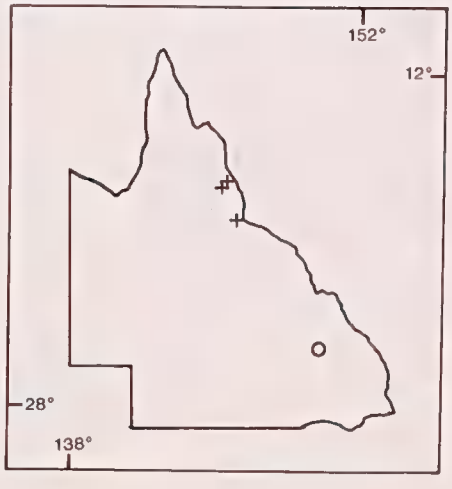

Figure 9. Distribution of *E. granitica* (+) and *E. beaniana* (○).

cm wide, 15 cm long. *Adult leaves* disjunct, somewhat dorsiventral, ± glossy, ± broad-lanceolate, sometimes finely crenulate, acute, 8–15 cm long, 16–32 mm wide; petioles to 18 mm long; lateral veins moderately spaced, ± irregular; reticulum regular; oil glands medium size, moderately spaced; intramarginal vein continuous, distinct, 1.0–2.0 mm from margin. *Inflorescences* simple or compound, terminal or axillary; umbellasters usually 7-flowered; peduncles ± terete, 3–11 mm long; pedicels ± terete, 2–4 mm long. *Mature buds* ovoid to clavate, 5–6 mm long, 2–2.5 mm diam.; calyptra hemispherical, broadly apiculate, about ½ as long as hypanthium. *Fruits* cup-shaped, 3- sometimes 4-locular, 4–6 mm long, 4–5 mm diam.; calyptra scar and stemonophore ± continuous, flat, 0.2–0.4 mm wide; disc vertically depressed, c. 0.5 mm wide; valves

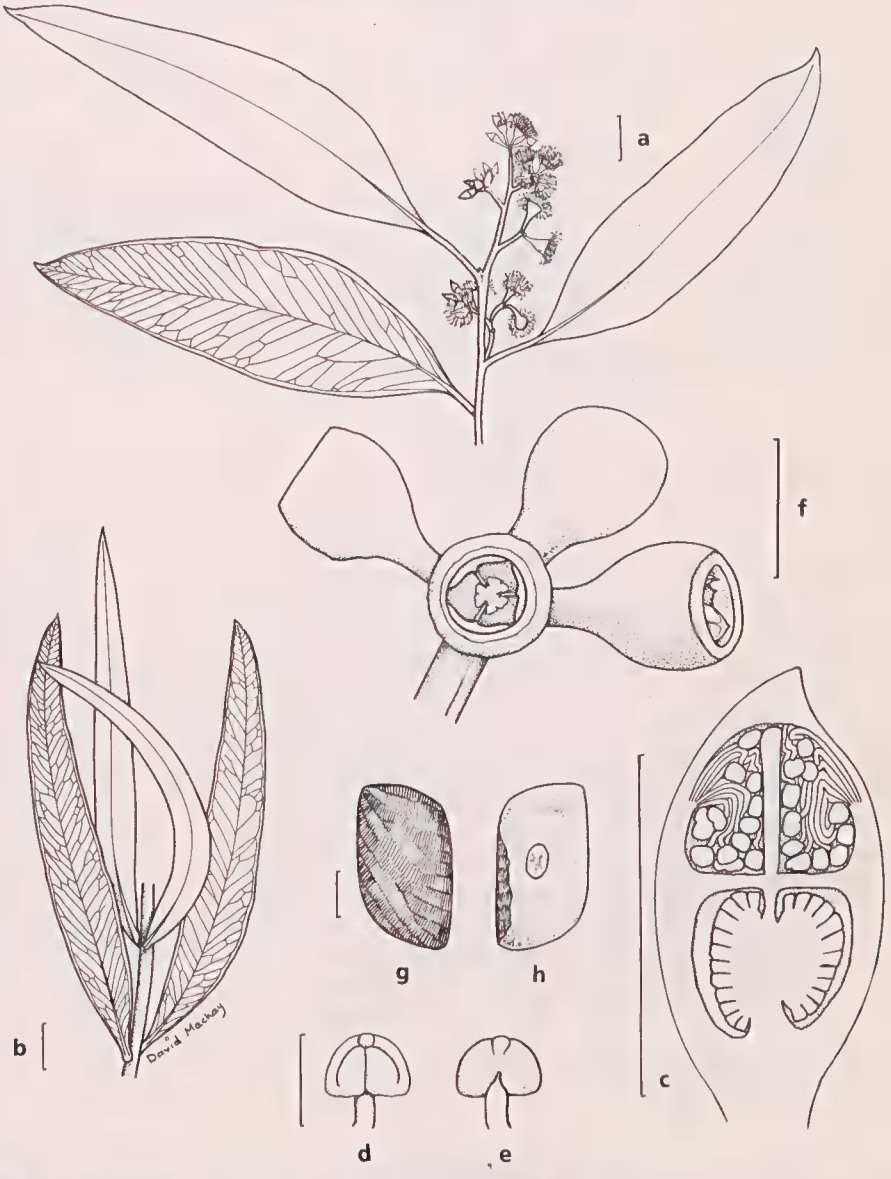

Figure 10. *E. granitica*. **a,** adult leaves, buds and flowers; **b,** juvenile leaves; **c,** median section of bud; **d, e,** anther; **f,** fruits; **g, h,** seed. (a from *Blaxell 2069*, b, f, g, h from *Hill 1111, Johnson & Blaxell*; c, d, e from *Clarkson 5706*). Scale bar: a, b = 1 cm; c, f = 5 mm; d, e, g, h = 0.5 mm.

broadly triangular, obtuse or acute, basally enclosed, apically ± at rim-level, raised at 60°–90°. *Seeds* dull, charcoal-grey, rounded, elliptical, regularly shallowly reticulate; hilum ventral; chaff pale brown. Figure 10.

E. granitica is relatively isolated in the *Crebrae*, and is distinguished by the glossy, lanceolate, subsessile, disjunct juvenile leaves and the glossy, broad-lanceolate, adult leaves. Adult leaves are also sometimes finely crenulate.

Distribution: North-eastern Queensland, Atherton Tableland to Paluma (Figure 9).

Ecology: Locally abundant on undulating to steep country, usually on coarse sandy soils over granite or acid volcanics, in areas of medium rainfall. Common associates are *E. abergiana* F. Muell., *E. intermedia* R. Baker, *E. resinifera* Sm., *E. citriodora* Hook., *E. cloeziana* F. Muell., *E. tereticornis* Sm. and *E. leichhardtii* Bailey.

The epithet is from the neo-Latin *graniticus*, relating to granite, and refers to the most common substrate.

Conservation status: Locally abundant over a wide area; not considered to be at risk.

Selected specimens (from 16 examined): Queensland: Herberton Range, Atherton to Herberton road, *Hill 1111, Johnson & Blaxell*, 15 Aug 1984 (NSW); 11.8 km from Atherton post office on Herberton road, *Blaxell 2069*, 28 Aug 1983 (NSW, BRI); 6.2 km from Herberton on Irvinebank road, *Hill 1117, Johnson & Blaxell*, 15 Aug 1984 (NSW, BRI, CANB, PERTH); 2.3 km from Herberton to Ravenshoe road on Kalunga road, *Hill 1129, Johnson & Blaxell*, 16 Aug 1984 (NSW, BRI, CANB, PERTH); 6.7 km E of Hidden Valley on Paluma road, *Hill 1160, Johnson & Blaxell*, 18 Aug 1984 (NSW, AD, BRI, CANB, MEL, PERTH).

7. Eucalyptus atrata *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. drepanophylla* distinguitur: folia juvenilia adultaque glauca, alabastra fructusque glauca, fructus majores.

Type: Queensland: c. 4 km from Irvinebank on Herberton road, *D.F. Blaxell 2067*, 27 Aug 1983 (holo NSW; iso AD, BRI, CANB, DNA, HO, MEL, MO, PERTH).

Tree to 15 m tall, often less. *Bark* persistent to smaller branches, hard black 'ironbark', smooth, cream or brown on branches less than 2 cm diam. *Juvenile leaves* disjunct, broad-lanceolate to ovate, to 7 cm long, 4.5 cm wide; petioles thick, to c. 12 mm long. *Adult leaves* disjunct, similifacial, lanceolate, acute, 8–13 cm long, 12–30 mm wide; petioles to 35 mm long (often less); lateral veins moderately spaced; intramarginal vein continuous, ± distinct, 0.5–1.5 mm from margin. *Inflorescences* simple or compound, terminal or axillary; umbellasters 3–7-flowered; peduncles terete to ± angular, 4–10 mm long; pedicels ± angular, 3–7 mm long. *Mature buds* ovoid, 5–7 mm long, 3–4 mm diam.; calyptra hemispherical to convex-conical, broadly apiculate, slightly shorter than hypanthium. *Fruits* cup-shaped to obconical, 3–4-locular, 5–7 mm long, 5–6 mm diam.; calyptra scar and stemonophore vertically raised, ± 0.5 mm wide; disc ± slightly depressed, 1–2 mm wide; valves broadly triangular, obtuse, basally enclosed, apically vertically exserted. *Seeds* dark brown, dull to slightly lustrous, finely regularly reticulate, elliptical; hilum ventral; chaff light brown. Figure 11.

Nearest to *E. drepanophylla* F. Muell. ex Benth., from which it is distinguished by the glaucous juvenile and adult foliage, buds and fruits, and the larger fruits (4–6 mm long in *E. drepanophylla*).

This taxon has in the past been confused with *E. whitei* Maiden & Blakely, which is characterised by opposite juvenile leaves, small adult leaves (often less than 9 cm long) on short petioles (less than 10 mm long), and the ovoid fruits with a steeply descending disc and deeply enclosed valves. *E. whitei* as now circumscribed ranges

from near Forsayth south to near Yalleroi.

DISTRIBUTION: Known only from the south-western fall of the Atherton Tableland, North Queensland (Figure 6).

ECOLOGY: Locally a community dominant in grassy forest or woodland on sandy soils over siliceous granites or rhyolites. Although on poor soils, this species favours the somewhat richer accumulations in surroundings of even lower nutrient status.

The epithet is from the Latin *atratus*, clothed in black, from the dark bark.

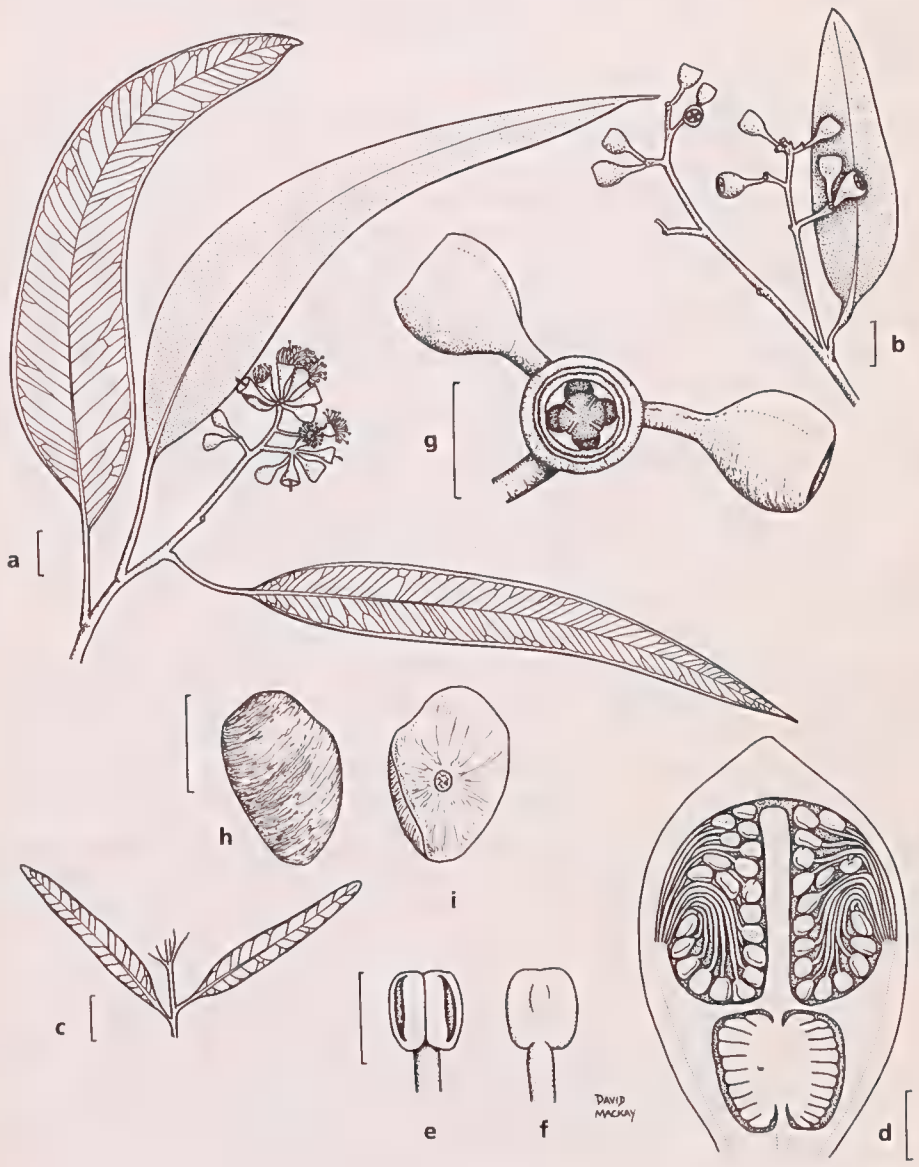

Figure 11. *E. atrata*. **a,** adult leaves and buds; **b,** adult leaves and fruits; **c,** seedling leaves; **d,** median section of bud; **e, f,** anther; **g,** fruits; **h, i,** seed (a, d, e, f from *Hyland 5802*; b, g, h, i from *Blaxell 1612*; c from *Hyland 5584*). Scale bar: a, b, c = 1 cm; g = 5 mm; d, h, i = 1 mm; e, f = 0.5 mm.

SELECTED SPECIMENS (FROM 13 EXAMINED):QUEENSLAND: Jumna Mine, Herberton to Irvinebank road, *Hill 1123, 1124, Johnson & Blaxell*, 15 Aug 1984 (NSW, BRI, CANB); 9 km from Herberton to Ravenshoe road on Kalunga road, *Hill 1131, Johnson & Blaxell*, 16 Aug 1984 (NSW, BRI, CANB, PERTH); c. 2 miles [3.2 km] W of Ravenshoe, *Johnson*, 21 May 1962 (NSW); Herberton – Watsonville road, *Hyland 5584*, 27 Oct 1971 (QRS, NSW); *Hyland 5802*, 25 Jan 1972 (QRS, NSW); camping reserve near 'Evelyn' homestead, NW of Ravenshoe, *Blaxell 1612*, 3 June 1978 (NSW, BRI).

8. Eucalyptus persistens *L. Johnson & K. Hill*, **sp. nov.**

E. normantonensis affinis sed ab illa distinguitur: habitus arborescens, cortex sub-fibrosus pro parte maxima persistens, atque calyptra externa persistens vel regulariter tarde sed ante anthesin cadens.

TYPE: QUEENSLAND: 4.8 km NE of Shuttleworth bore, 'Lou Lou Park' Station (22°15'S 146°09'E), *K. Hill 1182 & L. Johnson*, 21 Aug 1984 (holo NSW; iso BRI, CANB, MEL).

Bark persistent to branches smaller than 2 cm diam. *Seedling leaves* linear, basally tapered, sessile, opposite for 5–8 nodes. *Juvenile leaves* disjunct, lanceolate, petiolate. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, falcate, acuminate, 5–14 cm long, 5–28 mm wide, petioles 7–18 mm long; lateral veins well-spaced, irregular and anastomosing, at c. 10–30° to midrib; intramarginal vein distinct, 1–2 mm from margin. *Umbellasters* 7-flowered, axillary, on short, branched, leafless lateral or terminal shoots resembling panicles; peduncles slender, ridged, 4–15 mm long; pedicels slender, ridged, 3–8 mm long. *Mature buds* oval or pyriform, 3–5 mm long, 2–3 mm diam.; calyptra hemispherical, sometimes minutely apiculate, ½ as long as hypanthium; outer calyptra persisting to anthesis, or shedding some time beforehand and remaining attached to bud. *Stamens* all fertile; filaments erect and inflexed in bud; anthers basifixed, adnate, globular, cells indistinct, dehiscing by round terminal pores. *Fruits* cup-shaped to pyriform, 3–4-locular, 3–5 mm long, 3–4 mm diam.; calyptra scar distinct, depressed, less than 0.5 mm wide; disc depressed, less than 0.5 mm wide, continuous with calyptra scar; valves deeply enclosed, more or less erect.

E. persistens is nearest to *E. normantonensis* Maiden & Cambage, from which it differs in the tree habit and more extensive persistent bark. The latter is a half-barked mallee species from western Queensland and the Northern Territory. The outer calyptra sheds early and cleanly in *E. normantonensis*.

DISTRIBUTION: North-eastern Queensland, from Laura to Mareeba, west to Hughenden and Forsayth, south to around Marlborough (Figure 13).

The epithet is from the Latin *persistens*, persisting, referring to the abscission of the outer (calycine) calyptra being delayed compared with the condition in *E. normantonensis*, and also to the more extensive persistent bark.

Two subspecies are recognised.

Key to the subspecies

1 Outer calyptra persistent to anthesis ..... **8A.** subsp. **persistens**
1* Outer calyptra abscising before anthesis ..... **8B.** subsp. **tardecidens**

8A. Eucalyptus persistens *L. Johnson & K. Hill* subsp. **persistens**

Adult leaves narrow-lanceolate to broad-lanceolate, 5–14 cm long, 7–28 mm wide, petioles 7–15 mm long. Peduncles 5–15 mm long; pedicels 3–8 mm long. Mature buds 3–5 mm long, 2–3 mm diam.; calyptra hemispherical; outer calyptra abscising early

but remaining as a small cap until near anthesis. Fruits cup-shaped to pyriform, 3–4-locular, 3–5 mm long, 3–4 mm diam.

Subspecies *persistens* differs from subsp. *tardecidens* in that the outer calyptra is consistently persistent to anthesis, shedding with the inner calyptra.

Distribution: Mt Garnet south to around Marlborough and west almost to Hughenden and Lake Buchanan (Figure 13). The area is separate from that of subsp. *tardecidens*, but adjacent.

Ecology: Locally abundant but sporadic, in open woodland on lighter soils, often on elevated sites, or on skeletal soils on stony ridges.

Conservation status: Locally abundant over a wide area; not considered to be at risk.

Selected specimens (from 43 examined): Queensland: 2 miles [3.2 km] S of Middle Creek, Mt Garnet, *Hyland 5073*, 1 June 1971 (QRS, NSW); 35 miles [56 km] SSW of Mt Garnet, *Brooker 3411*, 1 Feb 1972 (CANB, NSW); 6 miles [9.8 km] ESE of 'Conjuboy' Station, *Perry 3745*, 5 July 1953 (CANB, NSW); 18.2 km S of Lynd Junction on Greenvale road, *Hill 1065 & Johnson*, 11 Aug 1984 (NSW, BRI, CANB, DNA, PERTH); Mingela, *Brooker 8962*, 30 Apr 1985 (CANB, NSW); Charters Towers, *Blake 11695*, 11 June 1936 (BRI, NSW); Bogie Range, *Smith 4529*, 9 Sep 1950 (BRI, NSW); 85 miles [136 km] N of Hughenden on The Lynd road, *Carolin 8514*, 11 Apr 1974 (NSW); Torrens Creek, *Hyland 6133*, 18 May 1972 (QRS, NSW); 2 km NW of Hazelwood Creek on Lizzie Creek Road, W of Mackay, *Brooker 5256*, 21 July 1976 (CANB, NSW); ca 15.4 km from 'Moonoomoo' Station turnoff on 'Bowie' to 'Yarromere' road, *Martensz 1229*, 6 Oct 1978 (CANB, NSW); 65 miles [104 km] NW of Rockhampton, *Lazarides 6872*, 29 June 1963 (CANB, NSW).

8B. Eucalyptus persistens *L. Johnson & K. Hill* subsp. **tardecidens** *L. Johnson & K. Hill*, **subsp. nov.**

Similis subspecie *persistenti* sed distinguitur: calyptra externa regulariter tarde sed ante anthesin cadens.

Type: Queensland: 5.0 km S of Mt Carbine on Mareeba road (16°33'S 145°09'E), *K. Hill 1066, L. Johnson & D. Blaxell*, 12 Aug 1984 (holo NSW; iso BRI, CANB, MEL).

Adult leaves narrow-lanceolate to lanceolate, 5–14 cm long, 5–25 mm wide, petioles 9–18 mm long. Peduncles 4–11 mm long; pedicels 3–6 mm long. Mature buds 3–5 mm long, 2–3 mm diam.; calyptra hemispherical; outer calyptra abscising early but remaining as a small cap until near anthesis. Fruits cup-shaped to pyriform, 3–4-locular, 3–5 mm long, 3–4 mm diam. Figure 12.

Subsp. *tardecidens* differs from subsp. *persistens* in that the outer calyptra abscises before anthesis, though it usually remains as a small cap on top of developing buds until shortly before anthesis. In contrast, the outer calyptra of *E. normantonensis* falls away completely long before anthesis.

Distribution: North-eastern Queensland, from Birricania north to Laura, in a zone passing through Hughenden and Forsayth. Subsp. *tardecidens* occupies a narrow band lying to the north and west of the distribution of subsp. *persistens* (Figure 13).

Ecology: Sporadically distributed but not uncommon, often on sandy soil in dry woodland in generally higher sites on undulating topography, or on stony rises, associated with a variety of species, or occasionally a community-dominant.

Conservation status: Locally abundant over a wide area; not considered to be at risk. The epithet is from the Latin *tarde*, tardily, and *-cidens* (combining form of *cadens*), falling, referring to the shedding of the outer (calycine) calyptra. Since it is a compound formed from an adverb (not an adjective or a noun) and a participle, article 73.8 of the I.C.B.N. does not apply, and the word is formed like *benevolens* or *suaveolens*, and does not have the connecting vowel '-i-'. The stress is on the (short) 'e'.

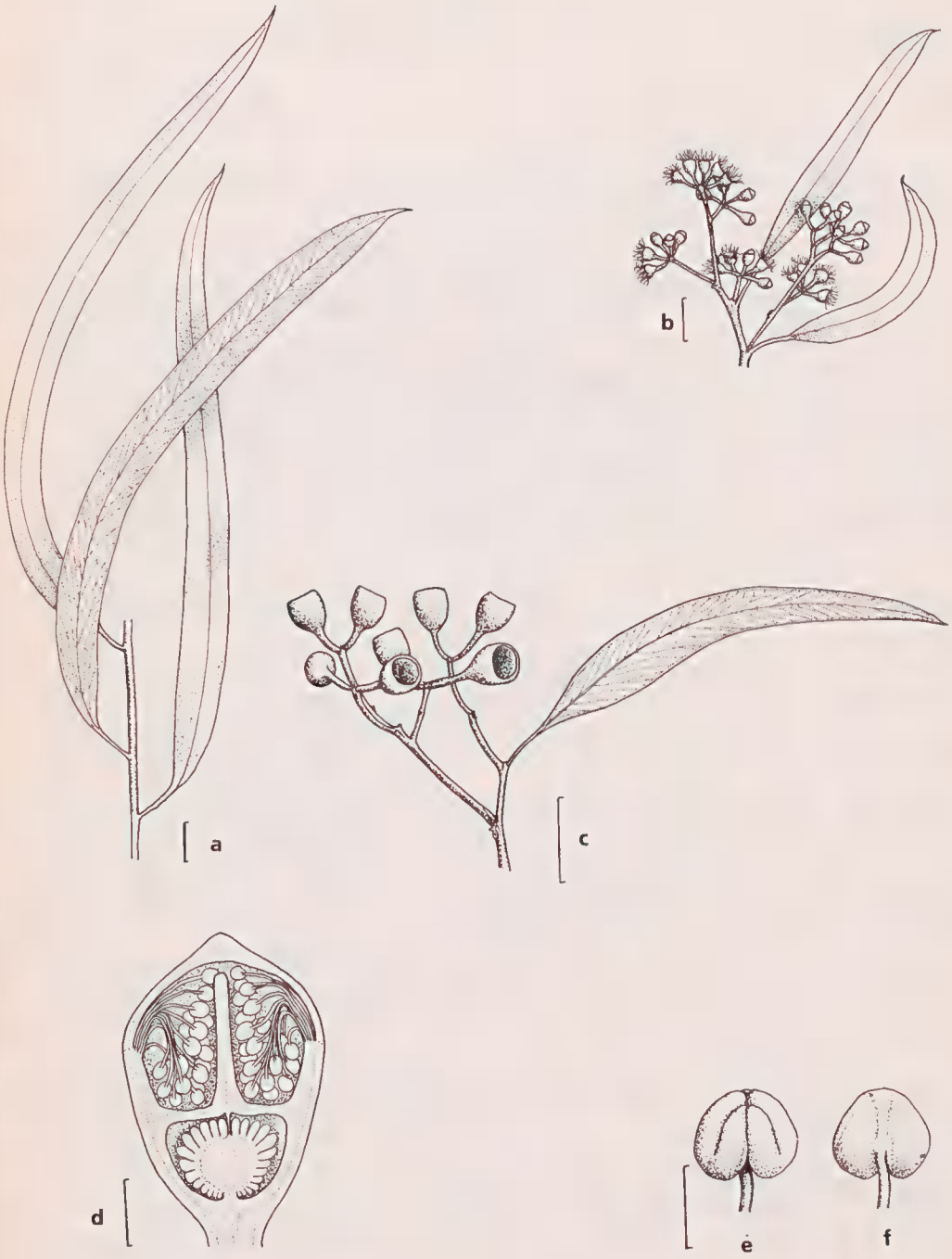

Figure 12. *E. persistens* subsp. *tardecidens*. **a,** adult leaves; **b,** adult leaves, buds and flowers; **c,** adult leaf and fruits; **d,** median section of bud; **e, f,** anther (all from *Hyland 5694*). Scale bar: a, b, c = 1 cm; d = 1 mm; e, f = 0.25 mm.

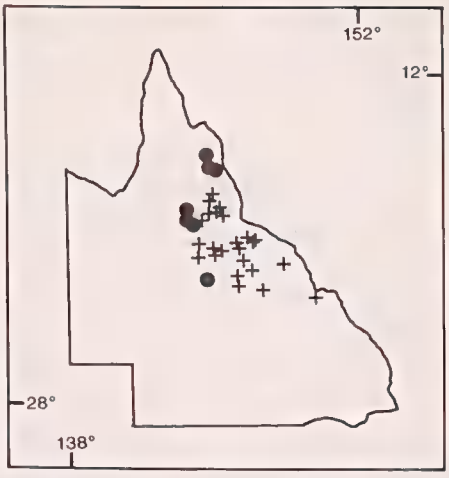

Figure 13. Distribution of *E. persistens* subsp. *tardecidens* (●) and subsp. *persistens* (+).

SELECTED SPECIMENS (from 25 examined): QUEENSLAND: Butchers Hill, c. 40 miles [64 km] direct SW of Cooktown, *B.G. Briggs 2024*, 5 Aug 1968 (NSW); Crest of dividing range north of Palmer River on Cooktown road, *Pedley 1914*, 21 Nov 1965 (BRI, NSW); Campbell Ck on Curraghmore Holding (16° 25'S, 145° 00'E), *Hyland 5694*, 18 Jan 1971 (QRS, NSW); 3 km N of Mt Carbine, *Bale*, 30 July 1975 (NE, NSW); 15 miles [24 km] E of Forsayth, *Johnson & Pryor*, 21 Oct 1964 (NSW); 20 km S of 'Robin Hood' Station on track to 'Percy Vale' Station, *Hill 1062 & Johnson*, 10 Aug 1982 (NSW, BRI, CANB, PERTH); Birricania, *White 18*, Apr 1919 (NSW).

9. Eucalyptus sicilifolia *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. paniculatae* combinatione characterum sequentium distinguitur: folia juvenilia linearia, folia adulta nitentia linearia vel anguste lanceolata, alabastra fructusque parvi.

TYPE: QUEENSLAND: Little St Peter Mountain, N of Springsure (23°55'S 148°01'E), *K. Hill 1190, L. Johnson & A. Bean*, 22 Aug 1984 (holo NSW; iso BRI, CANB, MEL).

Tree to 10 m tall. *Bark* persistent, dark grey ironbark, smaller branches smooth to c. 2.5 cm diam., cream. *Juvenile leaves* disjunct, linear, glossy, distinctly discolorous, to 10 cm long, 7 mm wide; petioles to 4 mm long. *Intermediate leaves* linear, to 16 cm long, 12 mm wide; petioles to 5 mm long. *Adult leaves* disjunct, linear to narrow-lanceolate, acute or acuminate, falcate, glossy, green, concolorous, amphistomatic, 7–12 cm long, 6–16 mm wide; petioles 9–17 mm long; lateral veins well-spaced, regular, at 30–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, 0.5–1 mm from margin. *Inflorescences* compound, comprising 3–7-flowered umbellasters aggregated on short lateral or terminal shoots, or sometimes axillary; peduncles 2–8 mm long; pedicels 2–5 mm long. *Mature buds* ovoid to broadly fusiform, 4–5 mm long, 2–3 mm diam.; calyptra double; outer shedding early; inner about two-thirds as long as and narrower than hypanthium, hemispherical or conical. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruits* ovoid-truncate, 4–5 mm long, 4–5 mm diam., 3–5-locular; stemonophore not persistent; disc depressed; valves enclosed or rim-level. *Seeds* ovoid to ellipsoid, dull to sub-glossy, dark red-brown, shallowly reticulate; hilum ventral; chaff red-brown. Figure 14.

Distinguished within the *E. paniculata* Sm. group by the linear juvenile leaves, the glossy, lanceolate or narrower, and distinctly falcate adult leaves, and the small buds and fruits. The only species with comparable bud and fruit size and shape in the group is *E. beyeriana* L. Johnson & K. Hill from New South Wales, which has dull grey-green juvenile and adult leaves.

DISTRIBUTION: Known only from the type locality and nearby volcanic hills (Figure 15).

ECOLOGY: Restricted to low woodland on the rocky top of trachytic volcanic plugs and the tops of surrounding scree slopes. Associated with *E. trachyphloia* F. Muell. and *Triodia*.

The epithet is from the Latin *sicilis*, a sickle, and *folium*, a leaf, alluding to the commonly curved (falcate) leaves.

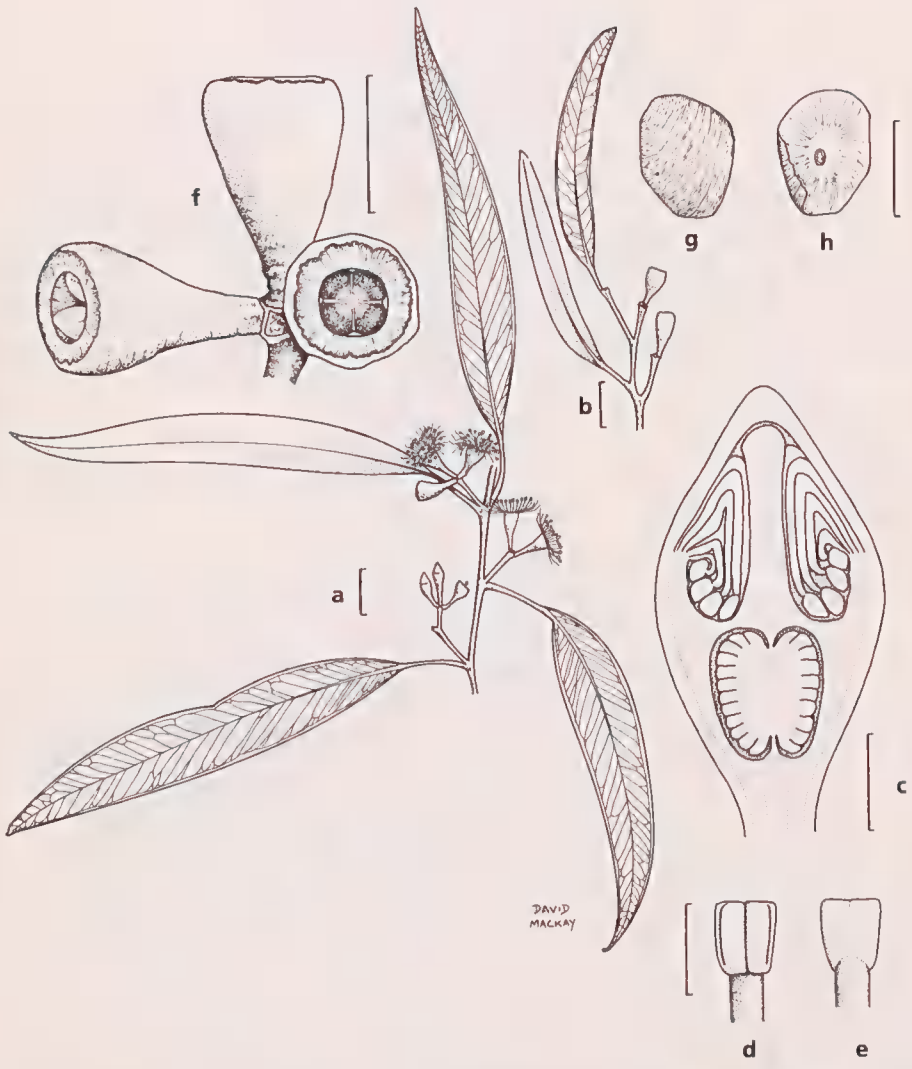

Figure 14. *E. sicilifolia.* **a,** adult leaves, buds and flowers; **b,** adult leaves and fruits; **c,** median section of bud; **d, e,** anther; **f,** fruits; **g, h,** seed (all from *Wallace 83065 & Hind*). Scale bar: a, b = 1 cm; g = 5 mm; c, h, i = 1 mm; e, f = 0.5 mm.

CONSERVATION STATUS: 2RC. Known from a restricted area, but included in the Mt Zamia Environmental Park.

SELECTED SPECIMENS (from 4 examined): QUEENSLAND: Little St Peter, near Springsure, *Wallace 83065 & Hind*, 23 Aug 1983 (NSW, BRI, CANB); Little St Peter, Lexington, N of Springsure, *Blake 6987*, 23 July 1934 (BRI, NSW).

10. Eucalyptus suffulgens *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. paniculatae* combinatione characterum sequentium distinguitur: folia adulta subnitentia amphistomatica anguste lanceolata vel lanceolata, alabastra plerumque clavata calyptra breviuscula plerumque acuta, fructus majusculi ovoidei vel ellipsoidei.

TYPE: QUEENSLAND: Callide open cut, c. 25 km north-east of Biloela (24°18'S 160°37'E), *L.A.S. Johnson 7123*, 2 June 1971 (holo NSW; iso BRI, CANB).

Tree to 25 m tall. *Bark* persistent, dark grey ironbark, smaller branches smooth to c. 5 cm diam., grey or cream. *Juvenile leaves* disjunct, petiolate, broad-lanceolate to narrow-ovate, glossy, distinctly discolorous, to 9 cm long, 4 cm wide. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, acute or acuminate, sub-glossy, green, very slightly discolorous or concolorous, amphistomatic, 8–17 cm long, 10–23 mm wide; petioles 9–17 mm long; lateral veins well-spaced, regular, at 30–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, 0.5–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots, or sometimes axillary; peduncles 8–22 mm long; pedicels 3–10 mm long. *Mature buds* ovoid, clavate or pyriform, 9–11 mm long, 5–6 mm diam.; calyptra double; outer shedding early; inner about half as long as and narrower than hypanthium with a distinct constriction at the junction, hemispherical or conical, rounded to acute or apiculate. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruits* ellipsoid to ovoid, 8–15 mm long, 6–11 mm diam., 4–5-locular; stemonophore persistent; disc vertically depressed; valves deeply enclosed. *Seeds* ovoid to ellipsoid, dull to sub-glossy, dark red-brown, shallowly reticulate; hilum ventral; chaff orange-brown. Figure 16.

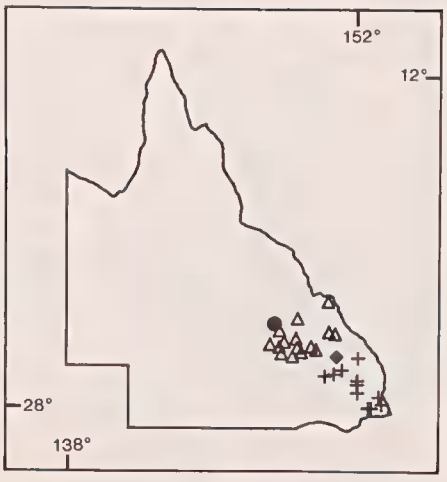

Figure 15. Distribution of *E. sicilifolia* (●), *E. suffulgens* (△), *E. dura* (+), and intergrades between the latter two species (◆).

Distinguished within the *E. paniculata* Sm. group by the subglossy, narrow-lanceolate to lanceolate adult leaves, the usually clavate buds with a relatively short, usually acute calyptra, and the relatively large ovoid or ellipsoid fruits. *E. suffulgens* is nearest to *E. dura* (below), which has broader adult leaves and smaller, obconic fruits. The two taxa show considerable intergradation in the zone lying between their ranges.

This taxon was recognised as distinct by Pryor & Johnson (1971), with the code 'SUV:A'.

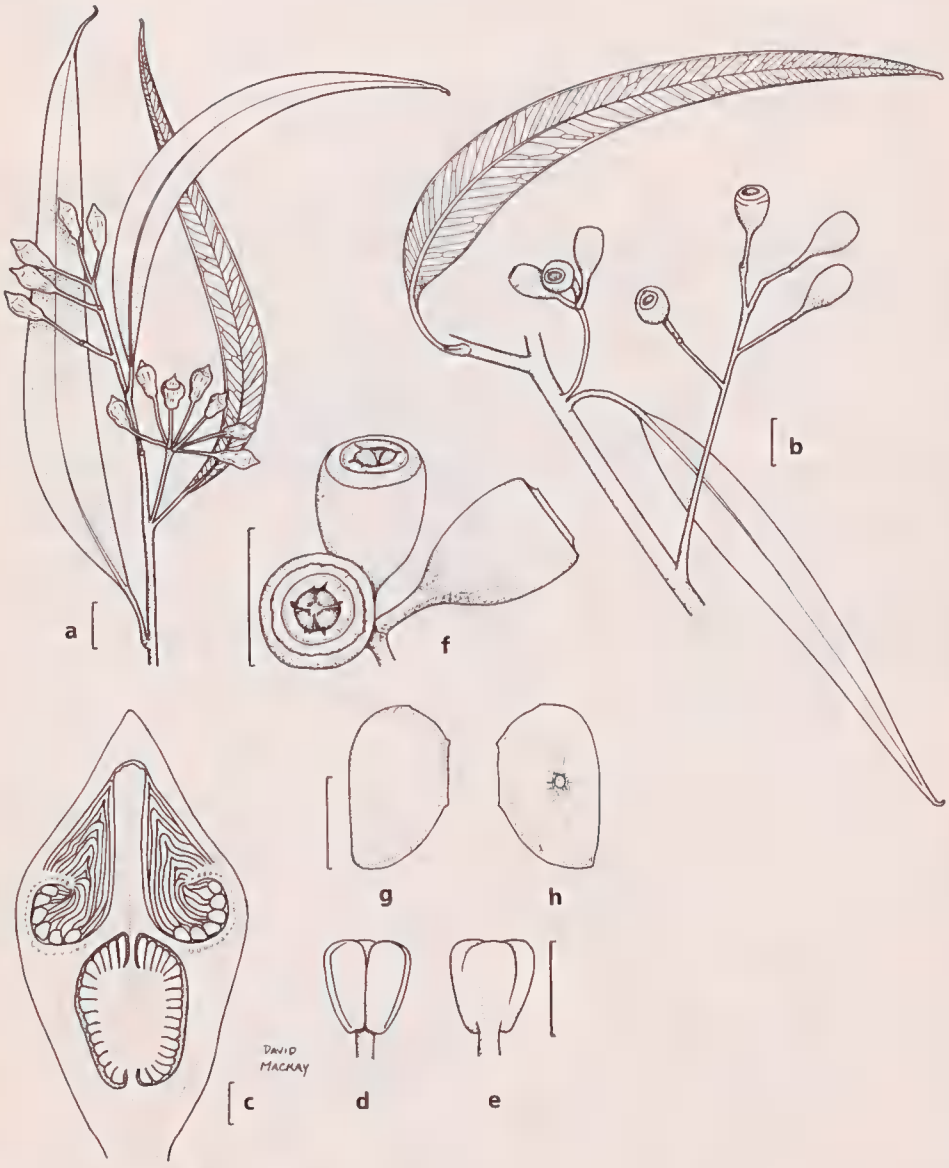

Figure 16. *E. suffulgens*. **a,** adult leaves and buds; **b,** adult leaves and fruits; **c,** median section of bud; **d, e,** anther; **f,** fruits; **g, h,** seed (all from *Johnson 7123*). Scale bar: a, b, f = 1 cm; c, g, h = 1 mm; d, e = 0.5 mm.

DISTRIBUTION: Ranges in the Byfield area, and the Blackdown Tableland and the Expedition, Dawson and Carnarvon Ranges and associated smaller ranges of Central Queensland (Figure 15).

ECOLOGY: A locally abundant species on shallow to skeletal soils over sandstone, often on crests of ranges and scarp lines.

Intergrading forms between this species and *E. dura* (below) occur where the ranges approach one another (24.3 km S of Cracow on Nathan Gorge road, *Blaxell 89/239, 241 & Johnson*, 10 Aug 1989 (NSW)).

The epithet is from the Latin *sub-* (assimilated to *suf* before f), in the sense of 'somewhat', and *fulgens*, shining, from the rather glossy foliage.

CONSERVATION STATUS: Locally abundant though patchy over a wide area; not considered to be at risk.

SELECTED SPECIMENS (from 32 examined): QUEENSLAND: Hills SW of Byfield, *Brooker 5269*, 23 July 1976 (CANB, BRI, NSW); c. 3.2 km SW of Kroombit Lodge, *Martensz 1052 & Kleinig*, 19 Aug 1976 (CANB, NSW); Wafers Spur, Blackdown Tableland (23°44'S 149°07'E), *Crisp 3009*, 13 June 1977 (CBG, BRI, CANB, NSW); Blackdown Tableland, 19.8 km SW of Umolo railway station, *Chippendale 1111 & Brennan*, 17 Sep 1974 (CANB, NSW); 15 miles [24 km] SE of Springsure on Rolleston road, *Blaxell 966 & Johnson*, 28 Nov 1972 (NSW); Boolimbah Bluff, Carnarvon Gorge, *Hill 1327*, 1 Jan 1986 (NSW); 65.8 km from Bauhinia Downs road on Glenhaughton road, *Brooker 7832*, 4 Dec 1982 (CANB, NSW); 10 km SW of Isla Gorge lookout, *Johnson 7185 A, B, C, D & B.G. Briggs*, 3 June 1971 (NSW).

11. Eucalyptus dura *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. paniculatae* combinatione characterum sequentium distinguitur: folia adulta coriacea subnitentia amphistomatica lanceolata vel late lanceolata, fructus obconici.

TYPE: QUEENSLAND: Turkey Mtn, Barakula State Forest, *K. Hill 1242, L. Johnson & A. Bean*, 25 Aug 1984 (holo NSW; iso BRI, CANB, PERTH).

Tree to 25 m tall. *Bark* persistent, dark grey ironbark, smaller branches smooth to c. 3 cm diam., grey or cream. *Juvenile leaves* disjunct, petiolate, broad-lanceolate to ovate, glossy, distinctly discolorous, to 12 cm long, 4.5 cm wide. *Adult leaves* disjunct, lanceolate to broad-lanceolate, often falcate, acute or acuminate, sub-glossy, green, very slightly discolorous or concolorous, amphistomatic, 9–14 cm long, 21–31 mm wide; petioles 9–26 mm long; lateral veins well-spaced, regular, at 30–50° to midrib, finely regularly reticulate between; intramarginal vein distinct, 0.5–2 mm from margin. *Inflorescences* compound, comprising 7-flowered umbellasters aggregated on short lateral or terminal shoots, or sometimes axillary; peduncles 7–20 mm long; pedicels 5–10 mm long. *Mature buds* ovoid, clavate or pyriform, 8–10 mm long, 4–5 mm diam.; calyptra double; outer shedding early; inner about half as long as and narrower than hypanthium with a distinct constriction at the junction, conical, acute or apiculate. *Stamens* regularly inflexed, outer whorls longer and infertile; anthers adnate, cuboid, oblique, dehiscing through terminal pores. *Fruits* obconical, 7–10 mm long, 5–7 mm diam., 4–5-locular; stemonophore persistent; disc vertically depressed; valves deeply enclosed. *Seeds* ovoid to ellipsoid, dull to sub-glossy, dark red-brown, shallowly reticulate; hilum ventral; chaff orange-brown.

Distinguished within the *E. paniculata* Sm. group by the coriaceous, sub-glossy, lanceolate to broad-lanceolate, amphistomatic adult leaves, and the obconical fruits. Nearest to *E. suffulgens* (above), but similar in leaf and fruit morphology to

E. fusiformis Boland & Kleinig, which differs in having dull adult and juvenile leaves, and somewhat more fusiform than conical fruits. *E. ancophila* L. Johnson & K. Hill from N.S.W. has similar subglossy lanceolate adult leaves that are considerably larger (to 20 cm long), and ± obconic fruit that are shorter (6–8 mm long) and on shorter pedicels (4–6 mm long).

DISTRIBUTION: Southern Queensland, from the Biggenden district west to Chinchilla and south to Boonah (Figure 15).

ECOLOGY: Sporadic and localised, in grassy or dry sclerophyll forest on sandy soils over sandstone, most often on higher points.

The epithet is from the Latin *durus*, hard, referring to the bark.

CONSERVATION STATUS: Locally abundant though patchy over a wide area; not considered to be at risk.

SELECTED SPECIMENS (from 18 examined): QUEENSLAND: Mt Walsh, 6 km SW of Biggenden, *Crisp 2612*, 28 May 1977 (CBG, AD, BRI, CANB, NSW); Turkey Mtn, Barakula State Forest, *Brooker 9013*, 7 May 1985 (CANB, BRI, PERTH, NSW); Yarraman, *Cameron Y 19*, July 1924 (BRI, NSW); Plunkett district, 2.3 km (direct) WSW of Chardons Bridge, *J.D. Briggs 214*, 19 Aug 1978 (CANB, BRI, NSW); Mt French, about 7 km W of Boonah, *Sharpe 2303 & B.K. Simon*, 15 May 1977 (BRI, NSW).

12. Eucalyptus reducta *L. Johnson & K. Hill*, **sp. nov.**

E. tindaliae affinis sed ab illa distinguitur: folia adulta minora, alabastra filamenta antherae minores, fructus minores et triloculares.

TYPE: QUEENSLAND: 1 km W of Tumoulin on Kaban road (17°33'S 145°26'E), *K. Hill 1132*, *L. Johnson & D. Blaxell*, 16 Aug 1984 (holo NSW; iso BRI, CANB, MEL).

Tree to 40 m high. *Bark* persistent to smaller branches, grey on surface, red-brown when freshly broken, long fibrous ('stringybark'); smooth and white on very small branches. *Juvenile leaves* opposite for few nodes, then disjunct, ovate to elliptical, apiculate, cordate to rounded basally, with dense 'stellate hairs' on all surfaces, to 5 cm long, 3.5 cm wide, often smaller; petioles 1–3 mm long. *Intermediate leaves* disjunct, glabrous, ovate, to 10 cm long, 6 cm wide; petioles 3–8 mm long. *Adult leaves* disjunct, ovate-lanceolate, oblique, falcate, with a somewhat bluish sheen, 7–10 (rarely –14) cm long, 12–20 (rarely –30) mm wide; petioles 9–18 mm long; lateral veins well-spaced, at 15–30° to midrib; intramarginal vein distinct, 1–2.5 mm from margin. Umbellasters axillary, more than 7-flowered; peduncles 7–11 mm long, terete; pedicels 1–2 mm long, grooved. *Mature buds* ovoid, 4–6 mm long, c. 3 mm diam.; calyptra hemispherical, sometimes very shortly rostrate, slightly shorter than hypanthium. *Anthers* all fertile; filaments erect and inflexed in bud; stamens c. 0.5 mm wide, reniform. *Fruits* hemispherical to cup-shaped, 3- rarely 4-locular, 5–7 mm long, 6–7 mm diam.; calyptra scar c. 0.5 mm wide, recessed; disc domed, 1–2 mm wide, continuous with hypanthium and calyptra scar, ultimately incurved; valves broadly triangular, enclosed, with a small exserted apiculate tip. *Seeds* dull brown, reniform, to 1.5 mm long; chaff similar, slightly smaller. Figure 17.

E. reducta differs from *E. tindaliae* Blakely in the smaller adult leaves (often to 14 cm long in the latter), and the smaller and 3-locular fruits (7–11 mm diam. and mostly 4-locular in the latter). The buds, filaments and anthers also tend to be smaller in *E. reducta*..

E. tindaliae is here taken to include *E. phaeotricha* Blakely & McKie (erroneously included in *E. nigra* R. Baker by Pryor & Johnson (1971) and by Chippendale (1988)).

While the types of the two names appear rather different, a full range between the two variants may be found in a single population, and we would regard them as conspecific. The type of *E. nigra* we include in *E. eugenioides* Sieber ex Sprengel.

DISTRIBUTION: QUEENSLAND: Atherton Tableland south to the Paluma district (Figure 18).

ECOLOGY: Locally dominant on drier sites on higher parts of ranges, or sometimes in mixed forest with *E. tereticornis* Sm., *E. polycarpa* F. Muell., *E. intermedia* R. Baker, *E. tessellaris* F. Muell. and *E. drepanophylla* F. Muell. ex Benth.

The epithet is from the Latin *reductus*, with two meanings, 'reduced', referring to the smaller fruits with fewer loculi of this species in comparison with *E. tindaliae*, and 'remote', referring to the great disjunction in distributions of *E. reducta* and *E. tindaliae*.

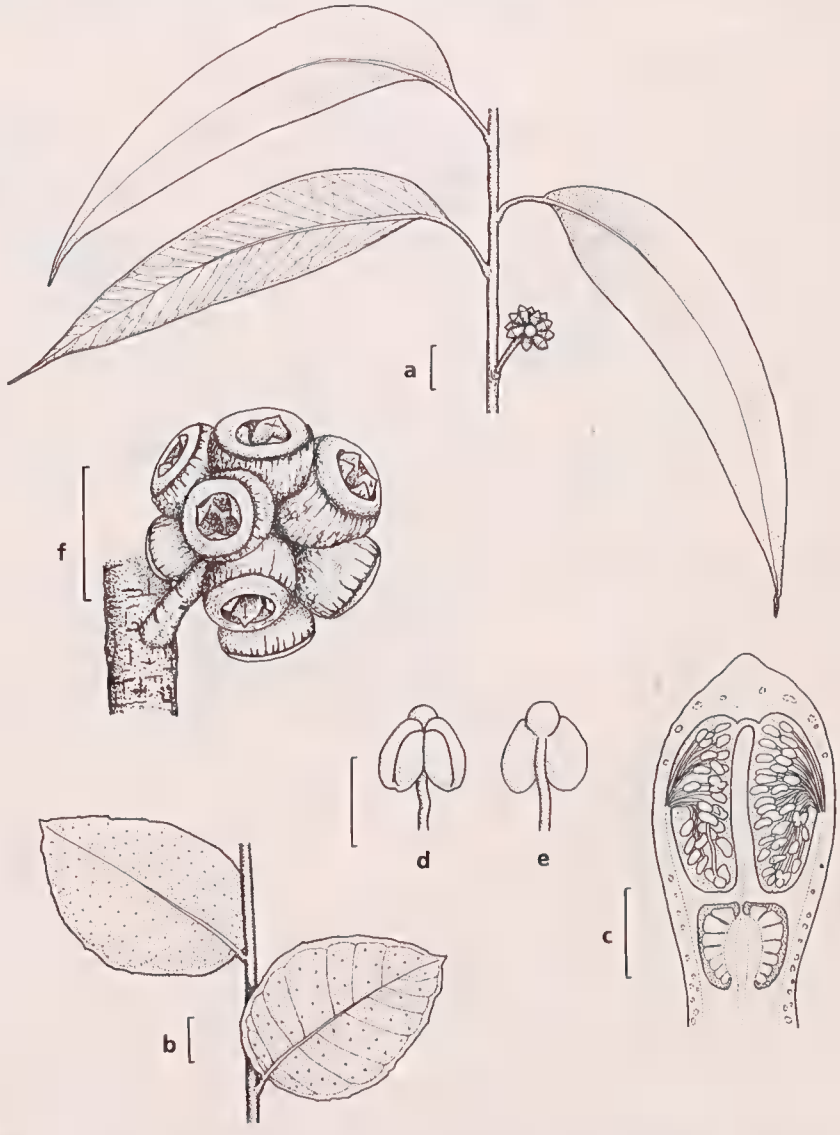

Figure 17. *E. reducta*. **a,** adult leaves and buds; **b,** juvenile leaves. **c,** median section of bud; **d,** **e,** anther; **f,** fruits (a, c, d, e, f from *Brooker 6524*, b from *Brooker 3343A*). Scale bar: a, b, f = 1 cm; c = 1 mm; d, e = 0.2 mm.

CONSERVATION STATUS: Locally abundant over a considerable area; not considered to be at risk.

SELECTED SPECIMENS (from 11 examined): QUEENSLAND: SFR 144, Windsor Tableland, *Hyland 4878*, 19 June 1969 (QRS, CANB, NSW); hills between Kuranda and Clohesy River, *Brooker 3343, 3343A*, 24 Jan 1972 (CANB, NSW); Herberton State Forest, *Brooker 6524*, 10 Oct 1979 (CANB, NSW); Herberton Range, c. 7 miles [11.1 km] S of Atherton, *Johnson*, 21 May 1962 (NSW); c. 5 km E of Wondecla, *Brooker 6826*, 10 Oct 1979 (CANB, NSW); Paluma road, 8 miles [12.8 km] W of Bruce Highway, near Paluma, *Johnson & Pryor*, 23 Oct 1964 (NSW).

13. Eucalyptus mensalis *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. cameronii* sed ab illa distinguitur: fructus minores plerumque triloculares, folia juvenilia lanceolata ad ovata, folia adulta late lanceolata ad anguste ovata.

TYPE: QUEENSLAND: 1.6 km S of Mimosa Ck, Blackdown Tableland, *D.F. Blaxell 734 & L.A.S. Johnson*, 26 June 1976 (holo NSW; iso BRI, CANB, MEL).

Tree to 45 m. *Bark* persistent to branches less than 3 cm diam., grey, long-fibrous ('stringybark'). *Juvenile leaves* mainly disjunct, lanceolate to ovate, acute to acuminate, with scattered 'stellate hairs' on all surfaces, to 7 cm long, 25 mm wide; petioles 2–6 mm long. *Adult leaves* disjunct, broad-lanceolate to narrow-ovate, oblique, falcate, glabrous, acute or acuminate, 4–10 cm long, 8–24 mm wide; petioles 7–13 mm long; lateral veins well-spaced, at 20–30° to midrib; intramarginal vein sometimes distinct, 0.5–2 mm from margin. *Umbellasters* axillary, more than 7-flowered; peduncles 7–12 mm long; pedicels c. 1 mm long. *Mature buds* ovoid, to 4 mm long, 2 mm diam.; calyptra broadly conical, obtuse, as long as hypanthium. *Fruits* hemispherical to cup-shaped, 3- rarely 4-locular, 4–5 mm long, 4-6 mm diam.; calyptra scar and stemonophore forming a distinct, narrow groove around hypanthium; disc slightly domed, c. 1 mm wide, ultimately incurved; valves broadly triangular, wholly enclosed or fine tips slightly exserted. *Seeds* dull, dark brownish black, reniform, to 1.5 mm long; chaff similar, smaller, brown. Figure 19.

E. mensalis is near *E. cameronii* Blakely & McKie, differing in the smaller, usually 3-locular fruits (5–6 mm diam. and usually 4-locular in the latter), the lanceolate to

Figure 18. Distribution of *E. reducta* (▽) and *E. mensalis* (○).

ovate juvenile leaves (ovate in the latter) and the broad-lanceolate to narrow-ovate adult leaves (usually lanceolate in the latter).

This taxon has been placed with *E. tindaliae* (*E. phaeotricha*) in the past. It differs in generally closer crown of bright green leaves (distinctly blue-green in the latter), the more persistent hispid juvenile leaves, and the smaller buds and fruits. In both habit and habitat there is much more resemblance to the small-leaved, tall forest species *E. cameronii* than to *E. tindaliae* and *E. reducta*.

DISTRIBUTION: QUEENSLAND: Blackdown Tableland, west of Rockhampton (Figure 18).

ECOLOGY: Locally common in tall forest on ridge crests on basalt-derived, often lateritic soil, associated with *E. sphaerocarpa* L. Johnson & Blaxell, *E. aff. acmenoides* Schauer and *Allocasuarina torulosa*.

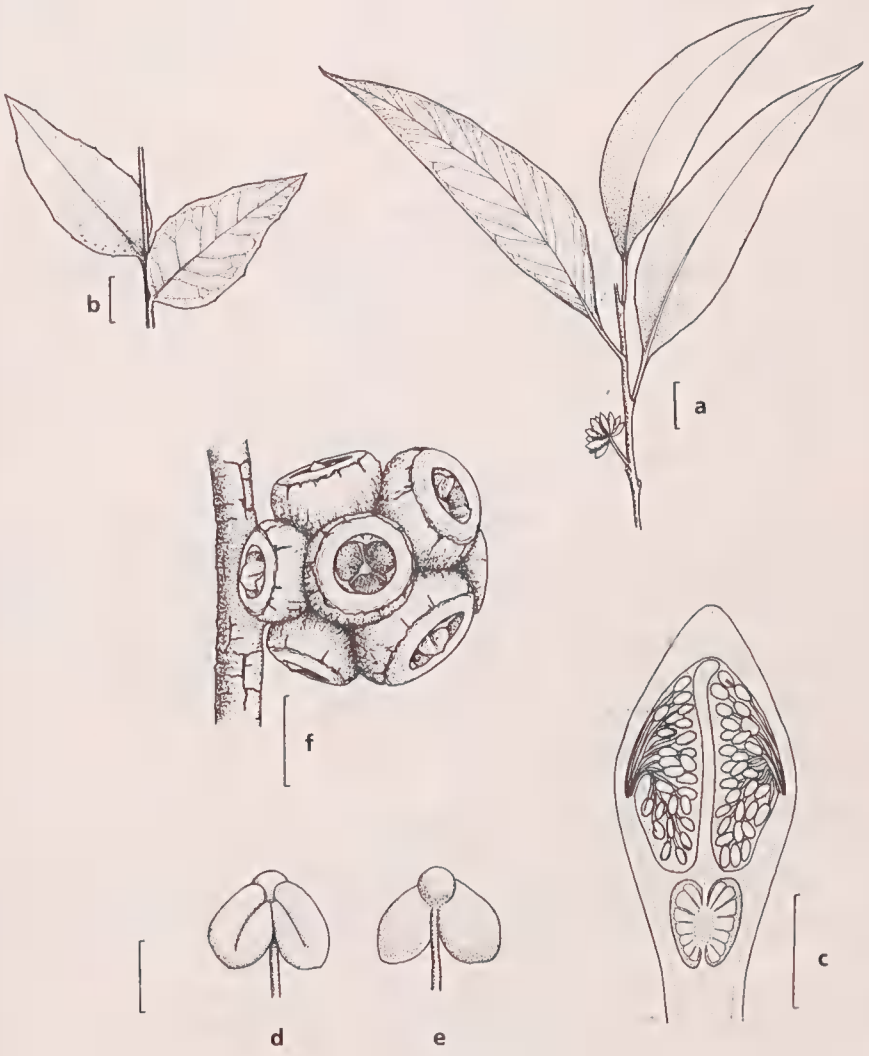

Figure 19. *E. mensalis*. **a,** adult leaves and buds; **b,** juvenile leaves; **c,** median section of bud; **d, e,** anther; **f,** fruits (all from *Crisp 2945*). Scale bar: a, b = 1 cm; f = 5 mm; c = 1 mm; d, e = 0.2 mm.

The epithet is from the Latin *mensa*, a table, and the Latin suffix *-alis*, belonging to, in reference to the occurrence of this species on tableland areas.

CONSERVATION STATUS: Locally abundant over a considerable area; not considered to be at risk.

SELECTED SPECIMENS (from 9 examined): QUEENSLAND: 2.5 km NW of Rainbow Falls, Blackdown Tableland, *Crisp 2945*, 11 June 1977 (CBG, CANB, NSW); campsite on Mimosa Creek, Blackdown Tableland, *Henderson 1053, Durrington & Sharpe*, 6 Sep 1971 (BRI, NSW); Blackdown Tableland, *Brooker 3770*, 31 Aug 1972 (CANB, NSW).

14. Eucalyptus microcodon *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. approximanti* et *E. codonocarpae* sed plus minusve intermedia. Ab *E. approximanti* distinguitur: folia adulta breviora latiora et tenuiora glandulis oleiferis minus prominentibus et venatione prominentiore acutioreque, umbellastra regulariter 7-flora. Ab *E. codonocarpa* distinguitur: folia adulta minora tenuioraque glandulis oleiferis minus prominentibus et venatione prominentiore acutioreque, fructus minores, umbellastra regulariter 7-flora.

TYPE: QUEENSLAND: Mt Barney, south ridge, *C.R. Dunlop*, 17 May 1969 (holo NSW; iso CBG).

Mallee to 6 m high. *Bark* smooth, cream, grey or brown, shedding in long strips. *Adult leaves* disjunct, lanceolate to broad lanceolate, 5–12 cm long, 8–16 mm wide; petioles 8–12 mm long; lateral veins often distinct, at 15°–30° to midrib; intramarginal vein distinct, 1.5–2 mm from margin. *Umbellasters* axillary, usually 7-flowered, rarely 3; peduncles narrowly flattened, 6–15 mm long; pedicels angular, 2–4 mm long. *Mature buds* pyriform, markedly verrucose, 5–7 mm long, 4–5 mm diam.; calyptra appearing single, hemispherical, sometimes broadly conical-obtuse, less than ½ as long as hypanthium. *Fruits* cup-shaped to urceolate, 3–4-locular, often apically flared, 6–8 mm long, 5–7 mm diam.; calyptra scar and stemonophore c. 0.5 mm wide, flat; disc 1.5–3 mm wide, flat or shallowly depressed; valves enclosed.

E. microcodon is intermediate between *E. approximans* Maiden and *E. codonocarpa* Blakely & McKie. It differs from *E. approximans* in shorter, broader, thinner leaves with less prominent oil glands and more prominent, more acute venation, and consistently 7-flowered umbellasters; and from *E. codonocarpa* in smaller, thinner leaves with less prominent oil glands and more prominent, more acute venation, the smaller fruits, and the consistently 7-flowered umbellasters. The nearest population geographically is *E. codonocarpa* at Mt Norman, which is predominantly 3-flowered.

DISTRIBUTION: Border Ranges region of Qld and N.S.W., from Mt Barney (Qld) and Mt Glennie (N.S.W.) to the Lamington Plateau.

ECOLOGY: Locally common on skeletal soils on cliff or mountain tops of siliceous granite or rhyolite, usually part of or fringing sclerophyllous shrub communities.

The epithet is from the Greek descriptive prefix *micro-*, small, and the Greek *codon*, a bell, referring to the bell-shaped fruits, which are generally smaller than in the related species.

CONSERVATION STATUS: 2RC. Although occurring in small, sporadic populations, this species is restricted to habitats that are unlikely to suffer disturbance. Almost all populations also occur in national parks and reserves.

SELECTED SPECIMENS (from 6 examined): QUEENSLAND: Mt Barney, *Everist 1391*, 13 Oct 1935 (NSW, BRI); Mt Barney, *Constable*, 15 Nov 1952 (NSW 24089); above Picnic Creek, Lamington National Park, *Johnson*, 20 May 1951 (NSW 172321). NEW SOUTH WALES: North Coast: Mt Glennie trig, *Floyd 547*, 4 Aug 1977 (NSW).

Acknowledgements

Thanks are due to Leonie Stanberg, who has provided essential assistance through the project, and drafted the distribution maps. David Mackay prepared the illustrations. Lani Retter provided much assistance in earlier stages of the investigations. The work was in part supported by grants from the Australian Biological Resources Study, which are gratefully acknowledged.

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References

Bentham, G. (1867) *Flora Australiensis*, vol. 3 (L. Reeve: London).
Blakely, W.F. (1934) *A key to the eucalypts*. (The Worker Trustees: Sydney).
Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants*. Revised edition. Australian National Parks and Wildlife Service Special Publication 14.
Carr, D.J. & Carr, S.G.M. (1985) *Eucalyptus 1* (Phytoglyph Press: Canberra).
Chippendale, G.M. (1988) *Eucalyptus*. In A.S. George (ed.), *Flora of Australia*, vol. 19 (AGPS: Canberra).
Johnson, L.A.S. (1962) Studies in the taxonomy of *Eucalyptus*. *Contr. New South Wales Natl. Herb.* 3: 103–126.
Johnson, L.A.S. (1972) Evolution and classification in *Eucalyptus*. *Proc. Linn. Soc. New South Wales* 97: 11–29.
Johnson, L.A.S. & Briggs, B.G. (1984) Myrtales and Myrtaceae – a phylogenetic analysis. *Ann. Missouri Bot. Gard.* 71: 700–756.
Johnson, L.A.S. & Hill, K.D. (1990) New taxa and combinations in *Eucalyptus* and *Angophora* (Myrtaceae). *Telopea* 4(1): 37–108.
Ladiges, P.Y. (1984) A comparative study of trichomes in *Angophora* Cav. and *Eucalyptus* L'Hérit. *Austral. J. Bot.* 32: 561–574.
Maiden, J.H. (1903–33) *A critical revision of the genus Eucalyptus* (Govt. Printer: Sydney).
McVaugh, R. (1968) The Genera of American Myrtaceae – an interim report. *Taxon* 17: 354–418.
Pryor, L.D. & Johnson, L.A.S. (1971) *A classification of the eucalypts* (ANU Press: Canberra).

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A new species of *Grevillea* (Proteaceae: Grevilleoideae) from south-west Western Australia

R.O. Makinson & P.M. Olde

Abstract

Makinson, R.O.[1] & Olde, P.M.[2] ([1] National Herbarium Of New South Wales, Royal Botanic Gardens, Mrs Macquaries Rd, Sydney, NSW, Australia 2000;[2] Society for Growing Australian Plants, Grevillea Study Group, 138 Fowler Rd, Illawong, NSW, Australia 2234) 1991. A new species of Grevillea *from south-west Western Australia.* Telopea *(4)2: 351–355. Grevillea calliantha* R. Makinson & P. Olde, a new species closely allied to *G. hookeriana* Meisn., is described from the Cataby area of Western Australia, c. 140 km NNW of Perth, with notes on affinities and conservation status.

Introduction

This species was first brought to botanical attention by the Grevillea Study Group of the Society for Growing Australian Plants, who were provided with material by Alec Hooper of 'Zanthorrea' [sic] Nursery near Perth, W.A. The material had originally been gathered by Mr N. Foote 'in sandplain north of Perth'. Subsequent searches by Dr S.D. Hopper of the W.A. Wildlife Research Centre have located five small populations. Precise collection localities are omitted from this paper to minimize casual collecting of this endangered species; locality details may be obtained through the Western Australian Department of Conservation and Land Management.

Grevillea calliantha *R. Makinson & P. Olde,* **sp. nov.**

Grevillea hookerianae Meisner affinis, sed pistillis longioribus (28–40 mm longis), inflorescentiis decurvis et fructibus adultis, trichomis biramosis omnino exutis, pilos glanduliferes erectosque solum gerentibus differt.

Holotype: Western Australia: Irwin: ... near Cataby, *B.J. Conn 3283 & J.A. Scott*, 27 Sep 1989 (NSW 225106).

Spreading flat-topped shrub c. 1 m tall, 2–3 m wide; branches spreading or slightly ascending, somewhat secund on older plants; bark rough, grey over red-brown; branchlets (younger) flattened, strongly ridged, and tomentose with wavy hairs; when older the branchlets more terete, ridged, sublanate with curled hairs; branchlet indumentum whitish with reddish brown stripes corresponding to ridges and decurrent from the leaf-bases. *Leaves* greyish yellow-green, ascending, subsessile (appearing petiolate) or with petioles up to c. 3 mm long, pinnatipartite (almost pinnatisect), 4.0–7.5 cm long with (3–) 5–7 (–11, cultivated) entire ascending linear lobes, lobes 1–4.5 cm long, 1.0–1.1 mm wide, basal lobes longest; apex and apices of lobes acute with a sometimes-pungent point; margin smoothly revolute, enclosing the lower surface except for the midvein(s) of leaf and lobes; upper surface of leaves and lobes with an inconspicuous midvein; young leaves with an open to dense indumentum of wavy to curly hairs on upper surface and the exposed veins of the lower surface, older leaves becoming glabrous and faintly granulate on these parts; texture chartaceous. *Inflorescences* on older plants largely confined to a zone beneath and at the edge of the

layered foliage, terminal and simple but sometimes on short lateral branchlets arising from successive nodes and appearing branched, decurved to sigmoid from near the base of the peduncle, conspicuous, many (15–30) flowered, secund, centripetal, (?20–) 50–70 mm long; peduncles bracteate, densely tomentose, 5–15 mm long; rachises densely tomentose to sublanate with whitish hairs only, ridged beneath the indumentum, up to c. 60 mm long; bracts spreading (spreading to recurved, and conspicuous, on very young bud-bearing rhachises), ovate-acuminate, 2.2–2.9 mm long, 1.3–1.8 mm wide, outer and inner surfaces tomentose with straight to wavy hairs, bracts persistent at anthesis; pedicels 1.0–2.5 (–3.5, cultivated) mm long, tomentose; torus oblique at 15°–30°, 1.3–2.1 mm across, projecting strongly at the ventral side where it is adnate to the prominent nectary; perianth obliquely ovate to rather saccate below the curve, 2.2–3.0 (–4.0, cultivated) mm across, outer surface tomentose with white and reddish two-armed hairs (and rarely, cultivated NSW 228067, some simple erect multicellular glandular hairs), the indumentum longer (to villous) on the limb; inner surface of perianth glabrous; limb of bud spheroidal, 1.7–2.2 mm long, 2.4 mm wide; dorsal tepals (10.5–) 11.3–12.8 mm long, 1.8–2.6 mm wide; nectary conspicuous, prominent, spreading, linguiform, sometimes decurved at tip, usually partly enclosed within the torus, 0.7–1.9 mm long, projecting 0.3–0.6 (–0.8, cultivated) mm beyond the rim, margin entire; pistil (28.5–) 30–40 mm long; stipe absent or obscure, up to c. 0.5 mm long; ovary subsessile, 1.3–1.6 mm long, subvillous with two-armed hairs only, some reddish blotching evident in the indumentum; ovules attached about the medial position; style appearing glabrous but occasionally with two-armed hairs extending for about 2–3 mm above the ovary, and sometimes with few to many short (c. 0.1 mm) inconspicuous erect multicellular ?glandular hairs, especially on the ventral side, or glabrous throughout; apical c. 2 mm of style dilating smoothly into the back into the style-end; pollen-presenter ovate, oblique at c. 45°, strongly and obliquely convex, 1.1–1.5 mm long, 1.0–1.2 mm wide, 0.3–0.5 mm high, stigma distally off-centre. *Fruits* 2-seeded, more or less spreading from the rachis, erect to somewhat reflexed at the apex of the decurved pedicel, obliquely oblong-ellipsoid, somewhat laterally compressed, 13–18 mm long, 8–9 mm wide, c. 6 mm thick; styles persistent; surface with a dense matted tomentose indumentum of multicellular glandular hairs, sometimes interspersed with a few two-armed hairs (most or all of the two-armed hairs of the ovary shed as the fruit matures); on young fruits up to c. 8 mm long [e.g. *Hopper 6354*] two-armed hairs still predominate, with longitudinal reddish striping of the indumentum; mature fruits with surface beneath the indumentum unevenly pitted; pericarp 0.3–0.4 (–0.7, *Conn 3278*) mm across at the suture, 0.4–0.8 mm thick at centre-face, 0.5–0.8 mm thick at the dorsal side, texture weakly crustaceous. *Seeds* slightly curved, obliquely elliptical, 12.5 mm long, 5.0 mm wide, 2.0–2.5 mm thick; outer face convex, with a slight submarginal ridge, tissue outside the ridge paler than the central elliptical area; inner face with a central more or less flat elliptical area c. 6.0 mm long and 1.0 mm wide, surrounded by an outer ring of radially-oriented upright lamellae of papery or waxy tissue. Figure 1.

The epithet is derived from the Greek *callos*, beauty, and *anthos*, a flower.

VARIATION: Minute glandular hairs occur on the style (usually confined to the ventral side in the middle third) in some collections (e.g. *Conn 3278*, NSW 225098); these can be almost undetectable on dry or reconstituted material. In some (cultivated) material (e.g. *Olde*, NSW 228067), these hairs are numerous and form an open indumentum over most of the style. Occasional glandular hairs may also occur in the indumentum of the outer surface of the perianth.

Leaves of some cultivated plants differ from wild-source collections in having up to 11 lobes (as opposed to 3–7).

The collection *Conn 3278* has many digynous flowers interspersed with normal flowers.

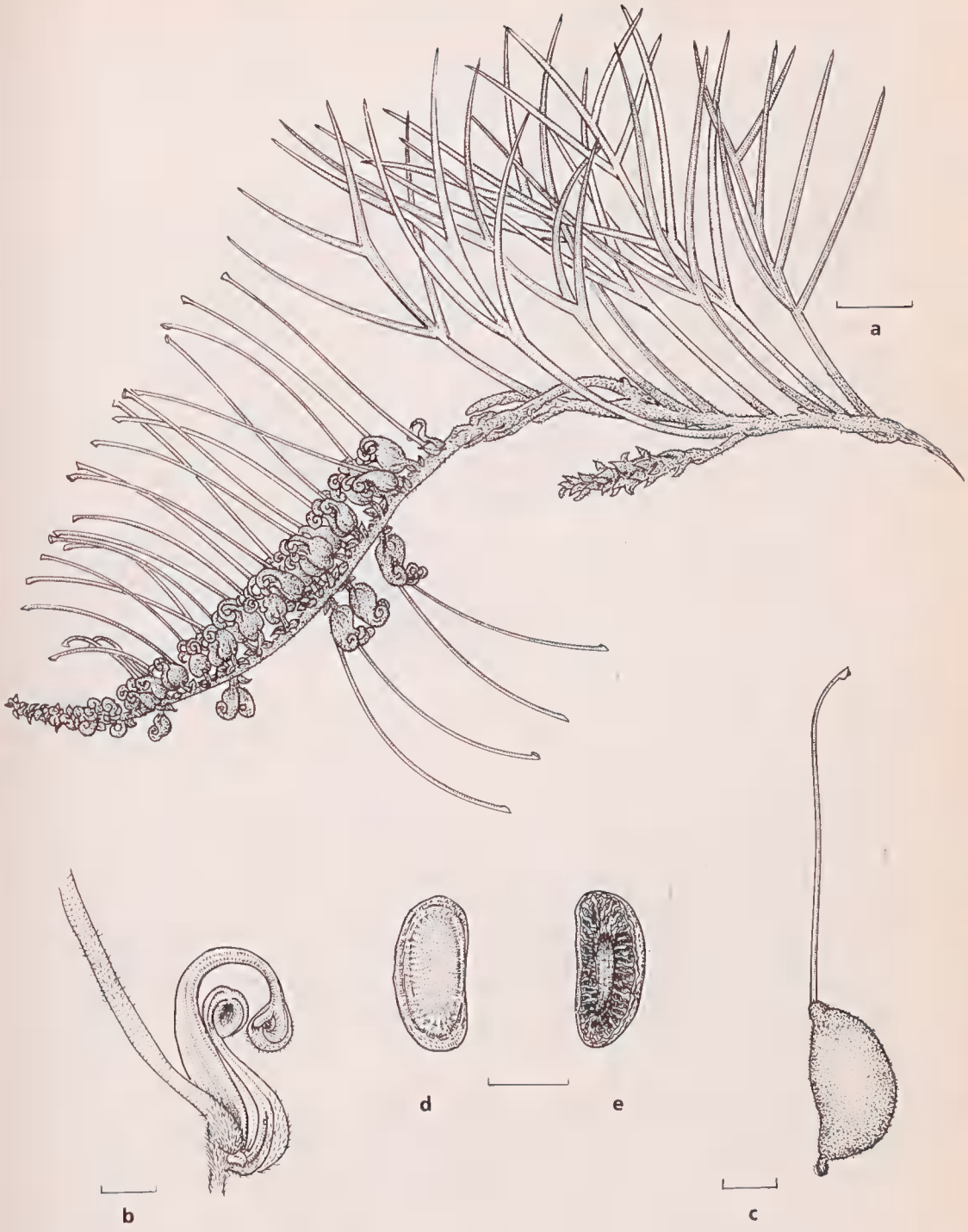

Figure 1. *Grevillea calliantha.* **a,** flowering branch, scale bar 10 mm; **b,** flower, half perianth removed to show ovary and nectary, scale bar 2.5 mm; **c,** fruit, side view, scale bar 5 mm; **d,e,** seed, outer and inner faces respectively, scale bar 5 mm. (All from *Conn 3278*).

Flower colour: Perianth outside greenish-yellow, ageing to apricot orange; limb often reddish; exposed inner surface of 'throat' region (just below limb) reddish.

Distribution and conservation status: Western Australia: known from five small vulnerable populations in the Cataby area, c. 140 km NNW of Perth. Four of these are of a few plants only, confined to narrow road verges. A larger population of c. 50 plants has been reported (S.D. Hopper, pers. comm.) on private property in the same area.

G. calliantha is listed and illustrated in Hopper et al. (1990: 19, and t. 173) as '*G.* sp. (Dandaragan) *Hopper 6350*, 'Foote's Grevillea''. The species is omitted (perhaps inadvertently) from the appendices of that work which assign conservation priority ratings. The species is not known to occur in any reserve and should receive a 'Priority One' listing according to the criteria given there. In the scheme of Briggs &Leigh (1988) an appropriate grading would be 2E (restricted distribution of < 100 km, endangered); see summary of codes at back of issue.

Habitat and ecology: In remnant heaths on low rises on lower valley slopes in grey to yellow-brown sandy soils over lateritic gravel; associated species include *Eucalyptus todtiana, Allocasuarina humilis, Lambertia multiflora, Acacia saligna, Calothamnus quadrifidus, Gastrolobium spinosum, Hakea trifurcata, Dianella revoluta, Pericalymma* sp., *Patersonia* sp., *Conospermum* sp., *Acacia ?pulchella*.

In cultivation: The species has definite horticultural potential; it is fairly fast-growing with conspicuous and attractive inflorescences. It has been grown successfully in Western Australia, western and north-eastern Victoria, and in central New South Wales; its hardiness in summer-humid situations is still being evaluated. A clone held by 'Zanthorrea' nursery is particularly attractive. Some clones have been sold commercially in recent years as *Grevillea* 'Black Magic'.

Affinities: *G. calliantha* is a member of the group of species defined by Bentham (1870: 419) as Series Hebegynae (type species: *G. pteridifolia*); the group is best characterized by a declined perianth tip, a glabrous inner surface of the perianth, a hairy ovary, and indumentum of late ovary and fruit with light and dark-coloured two-armed hairs arranged to form stripes or blotches (the colour deriving from dark cell contents). The group includes several south-west Australian species around the complex defined by McGillivray (in press) as *G. hookeriana* Meisn. Races 'a' and 'b' (sensu McGillivray) of *G. hookeriana* (no synonyms) are the closest relatives of *G. calliantha*. The two species share the apomorphous characters of large spreading ovate floral bracts, dark purple to blackish style, a spreading linguiform nectary, and seeds with a complex submarginal lamellate structure on the inner face. *G. calliantha* differs from *G. hookeriana* in having longer pistils (28–40 mm as opposed to 18–22 mm), decurved inflorescences, and the developing fruits shedding all, or nearly all, two-armed hairs and acquiring a dense indumentum of simple glandular hairs (*G. hookeriana* retains both hair types on the mature fruit).

The presence of scattered glandular hairs on the style is a feature which also occurs sporadically in the *G. hookeriana* complex, in several allied species, and more prolifically in the rather more distantly related group of species around *G. bipinnatifida* R. Br. The closest known occurrence of *G. hookeriana* to Cataby is within 50 km, and an undescribed taxon related to *G. bipinnatifida* (*Hopper 6333*, PERTH) occurs only 10 km away, at Mt Misery. Either these taxa or others may have been in closer proximity before European settlement.

Selected specimens: Western Australia: Irwin: ... Cataby [area], *Hopper 6350 et al.*, 23 May 1988 (PERTH, AD, BRI, CBG, DNA, HO, NSW), *6351, 6352, 6353* (PERTH); ... near Cataby, *Conn 3278 & Scott*, 27 Sep 1989 (NSW 225098, AD, BRI, CANB, CBG, HO, MEL, PERTH).

Acknowledgements

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References

Bentham, G. (1870) *Flora Australiensis vol. 5* (L. Reeve: London)

Hopper, S.D., van Leeuwen, S., Brown, A., & Patrick, S. (1990) *Western Australia's endangered Flora* (Dept of Conservation & Land Management: Wanneroo, W.A.)

Briggs, J.D. & Leigh, J.H. *Rare or threatened Australian plants.* Australian National Parks & Wildlife Service Special Publication no. 14.

McGillivray, D.J. *A revision of* Grevillea *(Proteaceae)* [in press, Melbourne University Press; publication expected 1991].

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SHORT COMMUNICATION

Microcitrus garrawayae (Rutaceae) and its distribution in New Guinea and Australia.

During the compilation of a list of rainforest plants in south-east Queensland, I came across Stone's (1985) account recording *Microcitrus australasica* (F. Muell.) Swingle as occurring in southern Papua New Guinea. *Microcitrus australasica* has previously been considered to be endemic to the southern portion of the Moreton District in Queensland (Ross 1983) and the North Coast district of New South Wales (Jacobs & Pickard 1981) where it occurs in subtropical rainforest. Hence this record of Stone's was geographically unlikely.

On examining a rather fragmentary duplicate of *Brass 24924*, which is probably one of the collections cited by Stone (1985) (as *Brass 24934*), I found it to be conspecific with *Microcitrus garrawayae* (Bailey) Swingle, described from Cape York Peninsula, Queensland, and previously recorded as endemic to Australia (Bailey 1904, Swingle 1915). As R.W. Garraway is indicated as 'Mrs' on various labels at BRI of plants from Cape York Peninsula, the epithet of this taxon should be correctly *garrawayae* and not 'garrawayi' as given originally by Bailey (1904) or 'Garrowayi' as given by Swingle (1915).

Microcitrus garrawayae *(Bailey) Swingle*, J. Washington Acad. Sci. 5: 574 (1915) ['Garrowayi']; *Citrus garrawayae* Bailey ['garrawayi'], Queensl. Agric. J. 15: 491 (1904).

TYPE: QUEENSLAND: Cook District: Mt White, Coen, *R.W. Garraway* [AQ318411], 5.1904 (holo BRI!).

DISTRIBUTION: Restricted to Cape York Peninsula, Australia; and Goodenough Island in Papua New Guinea.

ECOLOGY: Plants grow in deciduous vine thickets as understorey shrubs.

SELECTED SPECIMENS (from 16 examined): PAPUA NEW GUINEA: Milne Bay District: Goodenough Is, *Brass 24924*, 10.1953 (BRI). AUSTRALIA: QUEENSLAND: Cook District: few km S of Stone Crossing, Wenlock River, 12°17'S, 142°05'E, *Sankowsky & Sankowsky 534*, 29.9.1986 (BRI); scrubs of Temple Bay, *Young 63*, 7.1923 (BRI); c. 1 km N of Pascoe River mouth, 12°29'S, 143°16'E, *Tracey 14760* 20.11.1977 (BRI); Chilli Ck, SW of Portland Roads, *Flecker N.Q.N.C.8678*, 10.4.1944 (BRI, QRS); Table Range, Dead Horse Ck, 12°55'S, 143°15'E, *Dockrill 759*, 23.10.1973 (QRS); Chester River, 13°40'S, 143°25'E, *Hyland 9430*, 23.7.1977 (QRS); on road between Peach Ck and Leo Ck, c. 30–40 miles [50-67 km] NE of Coen, 13°44'S, 143°15'E, *Webb & Tracey 9884*, 10.1969 (BRI); T.R. 14, Rocky River catchment, 13°47'S, 143°29'E, *Hyland RFK2845* 7.9.1973 (BRI); Lankelly Ck, 13°54'S, 143°15'E, *Hyland 8703*, 6.4.1976 (BRI, QRS); Mulangar in McIlwraith Range, *Hutchinson AQ171304*, 6.4.1976 (BRI); Western fall of McIlwraith Range, 13°55'S, 143°15'E, *Webb & Tracey 9784*, 10.1969 (BRI).

Acknowledgement

The Director of the Australian National Herbarium, Atherton (QRS), allowed access to collections at that institution.

References

Bailey, F.M. (1904) Contributions to the flora of Queensland. Queensl. Agric. J. 15: 491–495.
Jacobs, S.W.L. & Pickard, J. (1981) Plants of New South Wales (Govt. Printer: Sydney).
Ross, E.M. (1983) Rutaceae. In Stanley, T.D. & Ross, E.M., Flora of South-eastern Queensland vol. 1: 440–470. (Govt. Printer, Brisbane).
Stone, B.C. (1985) New and noteworthy paleotropical species of Rutaceae. Proc. Acad. Nat. Sci. Philadelphia 137: 213–228.
Swingle, W.T. (1915) Microcitrus, a new genus of Australian citrus fruits. J. Washington Acad. Sci. 5: 569–578.

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SHORT COMMUNICATION

Swainsona pyrophila (Fabaceae), a new name and synonymisation

Examination of specimens at the Natural History Museum London (BM) has shown that the two Sturt specimens that form the Type of *Swainsona laxa* R. Br. are specimens of the dissimilar but related species that has been known as *S. rigida* (Benth.) J. Black. As this fact makes these names synonymous, the species that has been known as *'S. laxa'* requires naming. This is published here to make the name available for use in the 'Flora of New South Wales' vol. 2. More detail on this species will be given in my revision of *Swainsona* (in preparation).

S. pyrophila *J. Thompson*, **sp. nov.**
(*S. laxa* auct. non R. Br.)

Aff. *S. rigida* sed stipulis grandibus fructibus valde membranaceis et foliolis non suppressis differt.

TYPE: SOUTH AUSTRALIA: Hambridge Reserve, Eyre Peninsula, *D. Symon 4288*, 10 Oct 1966 (holo NSW; iso AD, CANB, K).

An erect, soft-wooded, several-stemmed perennial to c. 1 m tall. *Stems* often 5 mm or more in diameter, almost glabrous, at most with a few minute, blunt, loose, basifixed flat hairs; conspicuously flexuose. *Leaflets* c. 17, obovate-oblong, glabrous, the lower mostly 10–25 mm long and 4–12 mm wide, the apex broad and slightly to conspicuously emarginate, sometimes with a blunt point. *Stipules* 4–7 mm long, conspicuous, green, broadly and obliquely ovate and usually very obtuse, joined in a sometimes very shallow abaxial ridge; often with minute marginal hairs. *Racemes* 15–25 cm long, with 15–20 yellow flowers c. 10 mm long, on sparsely and shortly pubescent pedicels 3-4 mm long. *Peduncle* 1–2 mm wide, without a pulvinus, glabrous. *Calyx* with the tube 1.5–2 mm long, the lobes deltoid and shorter than the tube. *Standard* c. 7–10 mm long and as wide or a little wider, without thickenings in the lower part. *Wings* c. 8 mm long, deltoid-ovate or occasionally obovate, the apex narrowly to very broadly obtuse. *Keel* 7–10 mm long and c. 5 mm deep, the apex acute to broadly obtuse, the tip rather lipped or somewhat retracted. Ovary 3.5–4 mm long, glabrous. *Style* thin-textured, slightly or scarcely tapered to the tip which is narrowed shortly from the top, with antrorse hairs on the narrow region. *Fruits* usually 2–30 mm long and 10–15 mm wide, lunate to broadly elliptic, much inflated, contracting to a narrow tapering base above a slender stipe, the tissue negligible.

A plant of sandy or loamy soil in mallee scrub in southern South Australia, north-western Victoria and south-western New South Wales; usually found after fire.

This species is named for its association with recently burnt areas; from the Greek *pyr, pyros*, fire, and *philus*, loving.

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Systematic studies in *Cyperus* section *Pinnati* (Cyperaceae)

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Abstract

Wilson, Karen L. (National Herbarium of New South Wales, Sydney, NSW Australia 2000) 1991. Systematic studies in Cyperus *section* Pinnati *(Cyperaceae). Telopea 4(3): 361–496.* The limits of *Cyperus* section *Pinnati* Kük. are extended to include thirty-two species (with ten subspecies). *C. astartodes, C. blakeanus, C. centralis, C. cracens, C. crispulus, C. fucosus, C. hesperius, C. isabellinus, C. latzii, C. orgadophilus* and *C. secubans* are described as new species. New subspecies are described in *C. cunninghamii* (subsp. *cheradicus* and subsp. *uniflorus*), *C. microcephalus* (subsp. *chersophilus* and subsp. *saxicola*), and *C. betchei* (subsp. *commiscens*), while *C. gunnii* subsp. *novaehollandiae* is proposed as a new combination. Two keys (one dichotomous bracketed, one multi-entry) to the species are provided. Gross morphology, vegetative and nut epidermal anatomy, and phytochemical features are discussed and used to distinguish species within the Section and also to distinguish this Section within *Cyperus* sens. lat. The unusual leaf anatomy (Metcalfe's *Mariscus* A-type) is shared with species in the related sections *Glutinosi, Thunbergiani* and *Turgiduli.* This is the only Section endemic to Australasia: the species are mostly confined to Australia but three extend to southern New Guinea and a few species have been recorded as naturalised in New Zealand and Europe. Section *Pinnati* is of phytogeographic interest since it is probably most closely related to section *Glutinosi* of the Americas and the islands of the eastern Pacific and Caribbean.

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> 'This section was erected by Kükenthal to include a most difficult series of endemic Australian forms. Though placed by the author in the subgenus *Mariscus* the first three species enumerated (*C. angustatus* R. Br., *C. dactylotes* Benth., and *C. gilesii* Benth.) are typical *Eucyperus* in structure, while most of the other species combine the characters of both subgenera as described above for *C. subulatus*. Kükenthal's arrangement of the forms and his key to them is very unsatisfactory, and what follows can be regarded merely as some contribution towards a better understanding of this most difficult group.' — Blake (1940: 42)

Introduction

Cyperus sens. lat. includes most (about 700) of the species in tribe Cypereae. Taken in this broad sense, the genus shows considerable variation and numerous attempts have been made to subdivide it, whether recognising the subdivisions at subgeneric level (e.g. Kükenthal 1935–36, Haines & Lye 1983, Tucker 1983) or as distinct genera (e.g. Raynal 1973). Taxa traditionally recognised include *Cyperus* L. sens. strict., *Kyllinga* Rottb., *Mariscus* Gaertn., *Pycreus* P. Beauv., *Remirea* Aubl. and *Torulinium* Desv. Characters used to distinguish these subdivisions have included type of dispersal unit (individual flowers, or whole spikelet, or corky segments of rachilla plus associated flower); number of style branches; nut shape and orientation; the number of flowers per spikelet. Recent treatments have also used Kranz versus non-Kranz vegetative anatomy (taken as an indicator of C_4 photosynthesis) to distinguish subgroups.

My interest in *Cyperus* section *Pinnati* began about twelve years ago when, in collaboration with L.A.S. Johnson, I began a critical examination of generic limits in tribe Cypereae. Results of that study have not been published because we were not satisfied with the placement of various problem groups of species, including section *Pinnati*. This Section and a few others, especially sections *Glutinosi* and *Laxiglumi*, blur the boundaries between *Cyperus* sens. strict. and *Mariscus*. I believe that these traditional groups should be re-classified on the basis of Kranz/non-Kranz anatomy and other characters such as the arrangement of spikelets in the partial inflorescences either digitately or spicately, to give two main groups (either as genera or subgenera): *Cyperus* sens. strict. (including *Mariscus*) and *Anosporum* (the C_3 species; at subgeneric level, this would be known as subgen. *Anosporum* (Nees) C.B. Clarke (Goetghebeur 1989)).

Sect. *Pinnati* is the only group in *Cyperus* sens. lat. endemic to Australasia. It is of phytogeographic interest since it is probably most closely related to the mainly American section *Glutinosi* (found in North, Central and South America, and islands of the eastern Pacific and Caribbean). Kükenthal (1935–36) erected the section *Pinnati* for a group of ten Australian species, based on various characters, including short rhizomes, narrow or absent rachilla wings, hemispherical and rather loose partial inflorescences (clusters of spikelets), persistent glumes, and glumes more or less remote and spreading so as to give a pinnate appearance to mature spikelets. Some of the taxonomic problems and confusion in section *Pinnati* are alluded to by Blake in the quotation above and by Domin (1915: 443–444).

Only limited material was available for earlier taxonomic studies. The few temperate species were mostly well-collected and well-defined by this century. However, the main concentrations of species are in the arid zone and the tropical monsoonal region with alternating wet and dry seasons ('wet/dry tropics') where extensive field work has become possible only recently. In the present study, gross morphological and

anatomical characters are used to re-define the Section. It is extended to include six species placed by Kükenthal in other Sections, as well as three species described by Blake (1940, 1947a), two by Wilson (1980), and eleven new species proposed here. Ten subspecies are recognised, in species where variation is geographically related.

It should be noted that, unless otherwise indicated, sectional names used here are as given in Kükenthal (1935–36) to facilitate reference to that work, which is the most recent complete revision of *Cyperus* sens. lat. Some names are not the earliest available (see below).

Materials

The study is largely based on the herbarium collections held at NSW, which have been greatly augmented in recent years by exchange specimens from other herbaria and individual collectors, notably Mr A.C. Beauglehole of Victoria (his herbarium is cited as 'ACB').

Specimens in other herbaria have been examined in situ or on loan, through the courtesy of the curators of: AD, B, BM, BRI, C, CANB, CGE, CHR, DBN, DNA, E, G, HO, JCT, K, KIEL, L, MEL, MO, NE, NT, NY, P, PERTH, PRE, SYD, TCD, UNSW, US. No more than twenty specimens per taxon have been cited: in some cases, I have seen over 100 specimens of a taxon, in others only about ten. A complete list is in the library of the Royal Botanic Gardens; requests for copies should be addressed to the Librarian. Collectors' names are given as surnames only, except for types and where there might be confusion ('Wilson' refers to the author).

Field studies have been very important in understanding habitat differences and the morphological variation within a species, data often very inadequately represented on herbarium specimens. I have undertaken extensive fieldwork in eastern, central and northern parts of Australia, but I have not visited the Pilbara and western Kimberley of Western Australia, or Cape York, Queensland.

Definition and discussion of characters

Vegetative characters

Habit

The majority of species in section *Pinnati* are tufted, some rooted shallowly, others deeply. A few of these tufted species are annuals or short-lived perennials (e.g. *C. gilesii* and *C. rigidellus*), while others are obviously perennial, forming big tussocks (e.g. *C. alterniflorus* and *C. gunnii*). Some seem to be facultatively annual, depending on environmental factors, especially availability of moisture and occurrence of fire (e.g. *C. dactylotes*, *C. holoschoenus* and *C. latzii*). Growth and habitat conditions are such that the morphology of these species can vary widely over time or between microhabitats within the same population, to the extent that two 'varieties' (as previously recognised) can be found on the one plant (see, for example, Blake's comments under *C. fulvus*).

Bulbously thickened culm-bases occur in *C. orgadophilus*, *C. sexflorus* and *C. sporobolus*; the bases are somewhat bulbously thickened in *C. blakeanus* and *C. centralis*, rarely so in *C. fulvus*. Unlike the majority of species of Cyperaceae, these six occur in dry-land habitats where soil water would be low for much of the year and fires would be relatively frequent and regular (at least in the tropical savannas in which the first

three species grow, and perhaps also in the arid and semi-arid regions in which the last three species are found).

Large tussock-forming and bulbous-based species frequently produce surculi (defined by Haines and Lye (1983) as new shoots, formed in the axils of lower leaves, that break through the leaf sheath to become extravaginal and then grow horizontally for a short distance before growing vertically). These allow limited vegetative spread. The difference between surculi and short rhizomes is one of degree rather than any fundamental distinction. The larger tufted or tussocky species could be termed either very shortly rhizomatous or surculose, but I have described them as tufted or tussocky on the understanding that such species mostly produce surculi to achieve the large tuft or tussock form.

The only distinctly rhizomatous species is *C. angustatus*, which has a long, delicate rhizome. The rhizomes are frequently broken off in herbarium specimens but remnants can usually be found amongst the fibrous roots. *C. lhotskyanus* is usually shortly rhizomatous or long-surculose, but occasionally tufted. Solitary culms broken off just above the root-level are also an indicator of these two species: if these plants are ripped from the soil rather than carefully dug up, the culms usually break off at ground level. In the more tufted species, at least portion of the root system remains with the culm. In the field, this is a useful characteristic for distinguishing *C. lhotskyanus* and *C. gunnii*, which often grow together.

A few species are characteristically viscid, particularly *C. ixiocarpus* and *C. cunninghamii*, which are viscid about the spikelets and along the leaves and culms when they are carrying mature inflorescences. *C. viscidulus* is less copiously viscid, and only so about the spikelets. *C. rigidellus* and *C. fulvus* occasionally have viscid spikelets, while *C. alterniflorus* may have viscid leaf bases. Rarely, some other species are viscid. I observed no obvious glands or other secretory regions, externally or microscopically in my (limited) sectioning of spikelets, like those reported by Burbidge (1946) in *Triodia pungens* and by Dell & McComb (1978) in various groups (mainly dicots and gymnosperms).

Culms

The overall height (i.e. culm plus inflorescence length) of the plant is given in the descriptions. A range is given for each taxon but it is frequently possible to find stunted individuals that fall below that range if one collects from a habitat extreme, say, the dry-land margin of a river-bank or a particularly shallow soil-pocket on a rocky outcrop. Culm diameter has been measured about halfway between apex and base. The culm cross-sectional shape varies from trigonous to terete or triquetrous, even within a species. The culm is more or less solid and without aerial nodes, hence the clustering of leaves at the base.

The culm surface is smooth in many species, but it is scabrous, at least near the apex, in some, notably *C. microcephalus* subsp. *microcephalus*, *C. portae-tartari* and *C. perangustus*. Others, such as *C. fulvus* and *C. gunnii*, have the culms occasionally scabrous.

The colour of the culms and other vegetative parts is a useful distinguishing feature in the field but virtually useless in the herbarium as all species fade greatly on drying. Since I have not observed all species in the field, notes on colour of vegetative parts are incomplete. Many species are yellowish green, corresponding to the darker tones of colour numbers 143 and 144 ('Grass Green' and 'Lettuce Green') of the Royal Horticultural Society colour chart. The range of colours is not great but can be useful in some cases, e.g. in distinguishing *C. carinatus* (blue-green) from *C. holoschoenus* (yellow-green).

Leaves

Most species have more or less evenly suberect spreading leaves. However, they are recurved at maturity in, for example, *C. sporobolus* and are strongly curled to circinnate towards the apex in *C. crispulus*, *C. rigidellus*, *C. secubans* and *C. microcephalus* subspp. *chersophilus* and *saxicola* (and occasionally so in *C. fulvus*).

Leaf laminas (and less commonly the sheaths) may be septate-nodulose, i.e. they have short transverse internal septa. This is most obvious in the more robust species and is generally only observable in dried specimens, when the tissues have shrunk around the septa.

Leaf length is too variable to be diagnostically useful. Leaves range from about half the length of the culms to somewhat exceeding them.

Leaf lamina width and shape in cross-section were examined at a point about halfway between the apex and the top of the sheath. Leaves all taper to a point and become triangular in cross-section near the apex. Most species have a scabrous midrib abaxially near the apex, even those that become canaliculate lower down the leaf. Developmental stage is important since the leaves in most species are more or less crescentiform when immature. Hence, these characters have been examined on the most mature complete leaf (i.e., fully elongated but not senescent) on a specimen.

Cross-sectional shape of the lamina varies considerably between species (see also page 379). Shape is strongly influenced by the degree of development of the midrib and the presence or absence adaxially of bulliform cells (most easily observed microscopically in cross-section). Many species have no obvious midrib except near the apex and are canaliculate (corresponding to the anatomical term 'crescentiform'). Leaf shape in cross-section is often at least slightly asymmetrical, more markedly so in those leaves without obvious midrib. In other species there is an obvious midrib on the abaxial surface of the lamina, often developed into a keel, and these leaves have been termed 'flat' or 'carinate' depending on the degree of lateral folding of the leaf. Anatomically, both terms are included in 'V-shaped'. When obvious abaxially, the midrib is mostly smooth at the halfway point, but it is scabrous in some species (e.g. *C. alterniflorus*, *C. microcephalus* subsp. *microcephalus*, *C. oxycarpus*, *C. portae-tartari*), and may be scabrous near the apex in all species. The abaxial surface is occasionally more generally scabrous, whether or not there is an obvious midrib (e.g. in *C. cunninghamii*).

A hypodermis is present beneath the adaxial epidermis in all species. This is reflected in the texture of the adaxial surface, which is often somewhat 'spongy' and is uniformly smooth and whitish in most species, with the outlines of the large epidermal cells seen as a reticulate pattern with a hand lens. The leaves of many species are relatively thick (e.g. *C. ixiocarpus*); others have thin and grass-like leaves (e.g. *C. isabellinus*). Some species have lateral nerves visible adaxially, e.g. *C. alterniflorus*, *C. isabellinus*, *C. lhotskyanus* and *C. portae-tartari*. These nerves may be caused by prominent vascular bundles or by small sclerenchyma strands beneath the adaxial epidermis. In contrast, small bundles may occasionally be present without producing visible nerves (e.g. in *C. carinatus* and *C. microcephalus* subsp. *saxicola*).

The leaves (and inflorescence bracts) of all species have colourless, usually minute, silicified projections from marginal cells (and often from the midrib of the abaxial surface as well). Metcalfe (1971) calls such projections prickles or prickle hairs. These prickles are denser and more obvious towards the apex of the leaf or bract. Towards the base of the lamina they are much sparser or even absent. In *C. holoschoenus*, for example, there are often no prickles except in the uppermost quarter of the leaf. My standard examination point for this character was the uppermost quarter to third of

the leaf. Being nearly transparent, the prickles are best viewed with a dissecting microscope against a dark background. The prickles are here characterised (Figure 1) in terms of:

(i) *density*. This takes into account the regularity of spacing as well as actual distance between prickles. The impression of density is influenced by the length and direction of the prickles (see (iii) and (iv) below). The categories used are: *dense*, when the spacing between prickles is ≤0.5 mm and fairly regular – in general, the distance between prickles in this category is no more than one and a half times the length of the prickles; *sparse*, when the spacing is generally 0.6–1.5 mm, although it may be as low as 0.1 mm in irregularly spaced specimens; *very sparse*, spacing greater than 1.5 mm.

(ii) *regularity*: *regularly* or *irregularly* spaced.

(iii) *length*: *very short*, less than 0.05 mm long – only seen in *C. hesperius*, *C. microcephalus*, *C. crispulus* and *C. viscidulus*; *short*, 0.05–0.1 mm long – all taxa may have prickles in this category; *long*, more than 0.1 mm long – the longest prickles, about 0.7 mm, were found in specimens of *C. fulvus*.

(iv) *direction*: *antrorse*, that is, directed towards the leaf or bract apex; *erect*, at 90 degrees to the margin; *retrorse*, directed towards the base of the leaf or bract; *flabellate*, aculeate or papillate prickles clustered in a fan-shape, that is, spreading in two dimensions.

(v) *form*: *aculeate*, prickles acutely pointed; or *papillate*, prickles obtuse-topped or rounded at the apex.

Taxa have a characteristic form of prickle, although there is some variation within *C. alterniflorus*, *C. carinatus* and *C. fulvus*. Most species have antrorsely aculeate prickles, which differ in density, length and regularity. Some have papillate prickles, either simple and erect, as in *C. gilesii* and *C. rigidellus*, or flabellate as in many

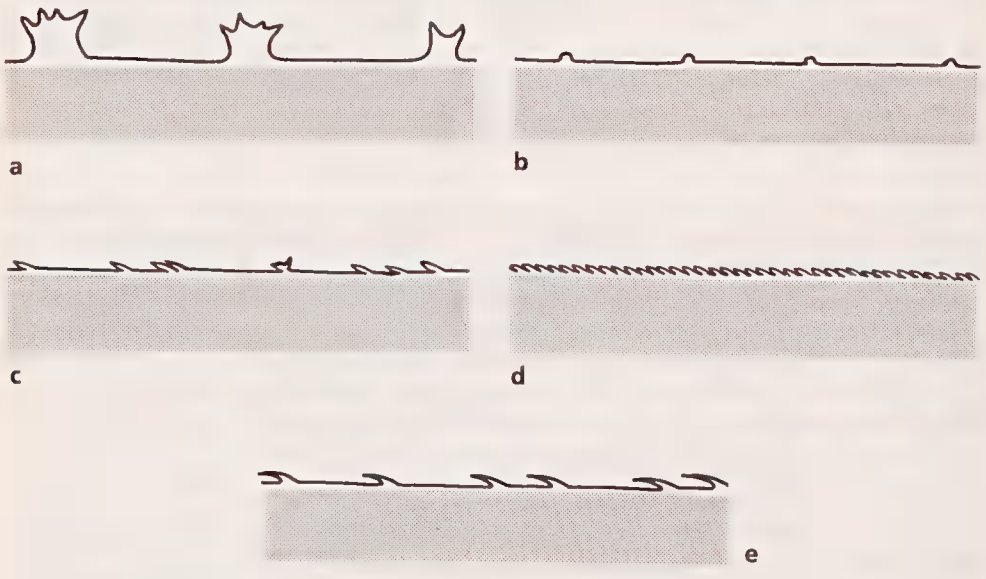


Figure 1. Marginal prickles on leaves and bracts (apex of leaf or bract to the left), X 20. **a**, Flabellate; **b**, papillate; **c**, mixed types, as seen in *C. lhotskyanus*; **d**, antrorsely aculeate (dense and short in this example); **e**, antrorsely aculeate (sparse and long).

specimens of *C. fulvus*. A few species have mixed types of prickles on the same leaf: *C. carinatus* has both papillate and aculeate prickles; *C. blakeanus*, *C. latzii* and *C. lhotskyanus* have simple aculeate prickles (a mixture of antrorse, erect and retrorse) as well as flabellate aculeate prickles.

Leaf sheaths are generally closed in species of Cyperaceae but in this group of species, as in many others, mature outer sheaths tend to rip open as more leaves, and ultimately an inflorescence-bearing culm, are produced within them from the basal meristem. The length of the closed portion of the sheath may be as little as 1 cm, in *C. clarus* and *C. fulvus*, or as much as 7 cm, in *C. gunnii*. The sheath includes a thinner-textured, often more or less hyaline, zone opposite the lamina, extending the length of the sheath and about one third of its circumference. This thin fragile zone is only obvious in young leaves and is readily torn as the plant grows.

The thicker-textured portion of the sheath is longitudinally striate and/or septate-nodulose in some species, whereas in others the surface is smooth and shining. These features are recorded for all species. Sheath texture varies from similar to that of the leaf lamina to thin and membranous. The general texture has not been included in most descriptions. Similarly, the texture of the sheath margins (i.e. the remnants of the torn zone) is not generally mentioned. They are most prominent in *C. cunninghamii*, which has broad white membranous margins. Sheath colour is reasonably consistent for a species, although the sheaths of plants in standing water tend to become dark brown or black. The colour of the internal (adaxial) surface of the sheath is generally similar to the external surface.

The number of photosynthesising leaves (that is, excluding old dried-up leaves) associated with each culm varies between about four and ten. Each species seems to have a characteristic range (e.g. *C. alterniflorus*, *C. gunnii* and *C. lhotskyanus* have 4–6 leaves per culm, *C. fulvus* has 8–10, *C. clarus* has 5–9).

Inflorescence characters

As is often the case, the relative constancy intraspecifically of features of the inflorescence and flowers makes them the major source of diagnostic and descriptive characters.

The inflorescence in *Cyperus* has been called an anthela (Kükenthal 1935–36), which is a variant of the corymb, differing from that in having the main axis shorter than the laterals, and with lateral axes of unequal length, thereby forming a funnel-shaped inflorescence as found in certain Rosaceae (Krasan 1864, Troll 1964). However, it is inappropriate to use the term anthela in this case since the inflorescence in *Cyperus* has the main axis ending not in a flower (as is found in corymbs) but in an open spikelet, that is, it is blastotelic and anauxotelic in Briggs & Johnson's terminology (Briggs & Johnson 1979) or polytelic in Troll's terminology (Troll 1964, Weberling 1989). Troll (1964: 63) had recognised this and foreshadowed his intention to introduce the term *anthelodium* for the 'spirrenartigen Infloreszenzen der Juncaceen und gewisser Cyperaceen' but never did so.

Whatever the appropriate name may be, the inflorescence in all species of section *Pinnati* is basically funnel-shaped in form, the longest branches being the lowest. At the base of each branch (above the subtending bract) is a tubular prophyll, the form of which varies little. Other features dealt with below are of more interest diagnostically.

Involucral bracts

At the base of the inflorescence in *Cyperus* there is usually an apparent whorl of leaf-like elongate involucral bracts. It is not a true whorl but rather a closely packed ascending sequence of involucral bracts, each bract subtending an inflorescence branch ('ray' of many authors). This is more obvious in species of *Cyperus* section *Tunicati* (e.g. *C. bulbosus* Vahl) in which the bracts are widely separated. Rarely, widely spaced bracts are present in species of section *Pinnati*, for example one specimen of *C. blakeanus* (*Wilson 3573*) has the lowest bract and branch separated by about 2 cm from the rest of the inflorescence. Anatomically and morphologically, the bracts appear homologous with the leaf lamina.

In section *Pinnati*, each species has a more or less constant number of involucral bracts that exceed the inflorescence and are held either erect or spreading. The majority of species have 2–4 such bracts but some species have only 1 or 2 (e.g. *C. angustatus*, *C. cracens* and *C. crispulus*) while a few have more (up to 8 in *C. portae-tartari*). In absolute terms, these bracts can be as long as 65 cm (in *C. gunnii*); relatively, they can be longer than the length of the culms, notably in *C. microcephalus* subsp. *saxicola*. The marginal prickles may be more densely packed than on the leaves.

Occasionally the small leafy bracts at the base of the individual spikelet clusters are obvious and reflexed, giving a characteristic appearance to those species (especially *C. perangustus* and *C. sporobolus*).

Inflorescence branching

The inflorescence is termed *simple*, *compound* or *decompound* depending on the order of branching present. Thus, where the spikelets are clustered at the apex of the primary branches the inflorescence is described as simple; where the primary branches bear a set of secondary branches that have the spikelets clustered at their apices, the inflorescence is compound. Inflorescences are termed *small-compound* if they have only a few short secondary branches, mostly no more than 2 cm long and always much shorter than the primary branches. Higher orders of branching occur: the maximum is quaternary branching in *C. portae-tartari*. Rarely, the inflorescence is reduced to a superficially head-like cluster (e.g. in *C. rigidellus*) but even then short branches are always present. Species generally exhibit one order of branching, but luxuriant or depauperate specimens of a species may have one order more or less than is usual.

The size of the inflorescence is described quantitatively in terms of the number and length of primary branches over 1 cm in length. In some cases there are also some shorter branches crowded together below the terminal spikelet but the congestion is too great for easy counting.

The parenchymatic swelling found at the base of branches and individual spikelets in *Cyperus* spp. appears to have the same function as a pulvinus or grass lodicules (Holm 1904) in spreading the relevant part relative to the axis (always permanently in this case). In sect. *Pinnati*, the branches and spikelets usually abscise just below the swelling, although they occasionally abscise just above it (e.g. in *C. cracens* and *C. perangustus*), leaving it as a rounded knob on the branch. This latter situation is also found in species traditionally referred to *Mariscus* (whether as genus or subgenus), such as *C. conicus* (R. Br.) Boeck., *C. cyperoides* (L.) Kuntze, *C. aggregatus* (Willd.) Endlicher and *C. javanicus* Houtt. Anatomical sections show an abscission layer of small thin-walled cells.

Dispersal units

At maturity, dispersal of propagules in section *Pinnati* takes place in one of three ways:

(i) the glumes and nuts fall (together or separately), leaving the persistent rachilla; OR

(ii) the whole spikelet falls as a unit, with or without the subtending bract and prophyll; OR

(iii) the ultimate branch falls as a unit with its terminal cluster of spikelets.

Glumes and nuts will fall together (whether in modes (i), (ii) or (iii)) if one or more of the following features is present: broad rachilla wings, broad and inrolled glume margins, viscid spikelets. Mode (i) has been considered characteristic of *Cyperus* sens. str., *Pycreus* and *Anosporum*, and (ii) characteristic of *Mariscus*, *Kyllinga* and *Remirea*. I have observed (iii) in only one other Section of the *Cyperus* alliance: section *Decidui* (with one species, *C. deciduus* Boeck.). [That Section was placed in subgenus *Mariscus* by Kükenthal but it has non-Kranz anatomy and belongs in *Anosporum*, whether that is treated as a genus or subgenus.]

In section *Pinnati*, twenty-three species exhibit more than one of these modes, the most common combination being (i) and (ii). All three modes are found in *C. microcephalus*, while nine species, including *C. hesperius*, *C. sporobolus* and *C. fulvus*, show only the first mode. This variation is rivalled in sections *Laxiglumi* and *Glutinosi*, but other exceptions to the traditional generalisations are not uncommon in subgenera *Cyperus* and *Mariscus* (sensu Kükenthal).

Spikelet clusters

In section *Pinnati*, spikelets are arranged in clusters at the apex of the ultimate inflorescence branches, mostly subdigitately but in some species shortly spicately. Where the arrangement is spicate (e.g. in *C. cunninghamii*, *C. blakeanus*, *C. fulvus* and *C. perangustus*), the spikelets are still relatively close-packed compared to the distantly spicate arrangement in other Sections of *Cyperus* (e.g. *Exaltati*, *Rotundi*, *Thunbergiani*).

The number of spikelets per cluster varies but species have been subjectively characterised as having 'dense' or 'loose' clusters when mature. This impression is dependent on spikelet width and maturity as well as number. The number of spikelets per cluster ranges from 1–7 in *C. portae-tartari* to 10–>15 in *C. fulvus*. When there are more than about 15 spikelets, they are clustered too densely for easy counting.

Diameter of the clusters can vary within a species, depending on growth conditions, but species generally have a characteristic combination of cluster shape and size. Shape is determined by the angle at which spikelets are held relative to the branch. Crowding can affect the angle in dense clusters but this is not the sole determinant since as few as three spikelets in a loose cluster will be spread widely. Clusters are usually hemispherical or globose in shape (rarely ovoid in *C. blakeanus*, *C. cunninghamii*, *C. orgadophilus* and *C. sporobolus*).

Spikelets

Spikelet shape in *Cyperus* is determined by the arrangement of glumes on the rachilla (which varies in the extent to which it zigzags), by the degree of lateral folding and flattening of the glumes, and by the number and crowding of glumes. Strongly laterally compressed glumes produce a compressed or flattened spikelet, rounded glumes a terete spikelet. In outline, these spikelets are respectively more or less oblong (tapering somewhat to the immature flowers at the apex) or linear. Spikelets with few glumes tend to be narrow-ovate in outline. Theoretically, the number of flowers in (and hence length of) the spikelet is unlimited, but in practice each species has a characteristic range. Unusual growth conditions may stunt or increase spikelets maturing in the following season, as discussed by Raynal (1971) for African species.

In section *Pinnati*, the glumes are nearly always arranged distichously on the spikelet rachilla. However, *C. blakeanus* occasionally exhibits spirodistichy (see, for example, *Latz 3961*). Spirodistichy is a twisted or distorted variant (because of crowding) of the

distichous condition (Snow 1955), found also in *Cyperus michelianus* (L.) Delile and *C. hamulosus* M. Bieb. Rarely, spikelets are also somewhat twisted in crowded clusters in *C. oxycarpus*. Glumes are at least somewhat laterally compressed relative to their midrib in all species except *C. cunninghamii*, in some forms of which the glumes are rounded in cross-section, producing a terete, linear spikelet.

Spikelet size is here described in terms of the number of flowers per mature spikelet and the length and width of mature spikelets. Variation is generally not great in section *Pinnati*, although a few specimens (e.g. a specimen of *C. fulvus*, *Pedersen N185* from the Burnett District of Queensland, and a specimen of *C. alterniflorus*, *Milthorpe & Cunningham 5175* from Wanaaring, N.S.W.) have a very different facies from the usual because of long spikelets.

In section *Pinnati*, the rachilla is generally thin and flattened, with the flowers inserted on the two flat faces, but in a few taxa, notably *C. microcephalus*, *C. hesperius* and *C. sporobolus*, it becomes thickened at maturity (the lateral faces are then about 0.1–0.25 mm wide). The rachilla is straight or may become slightly zigzag because of pressure from the maturing nuts.

The margins of the flattened faces of the rachilla have a broad or narrow hyaline, non-vascular, discontinuous wing in most species. The base of a wing is inserted on the rachilla within the base of a glume and is not physically joined to that glume. However, the upper end (relative to the spikelet axis) of the wing joins the glume developmentally next above, i.e. on the opposite face of the rachilla. The join is NOT always with the lower margin of that upper glume as may appear at first glance and as has been stated in the past. In at least some specimens the join can be seen under the dissecting microscope to be instead along a line a fraction of a millimetre *within* the margin (e.g. in specimens of *C. cracens* and *C. sexflorus*). I have seen this also in species in other Sections, such as *C. conicus* (R. Br.) Boeck. and *C. decompositus* (R. Br.) F. Muell. in sect. *Turgiduli*, and *C. leiocaulon* Benth. (sect. *Strigosi*). Traditionally the wing has been explained as a basal outgrowth from the glume inserted above it on the rachilla. However, this would not seem to hold, at least for those cases in which the wing does not meet the margin of that glume. Occam's Razor suggests that it is more likely that the wing in all species is an outgrowth from the rachilla. These wings may help enclose the nut; *C. cunninghamii* is an extreme example of this. In the descriptions, the wings are classed as *broad* if 0.10–0.25 mm wide, and *absent to narrow* if less than 0.10 mm wide. Care is needed in checking for the presence of these wings because they are fragile and may be torn off when removing the glumes, especially when the spikelet is viscid as in *C. ixiocarpus* or *C. viscidulus*.

The density of glumes distichously arranged along the rachilla, coupled with the length of the glumes, is characteristic for a taxon. The point of attachment of a glume is clearly defined on the rachilla by a scar. This provides a ready means of measuring glume density: the interval between two adjacent scars on the same flattened face of the rachilla (referred to here as *glume spacing*). This measure has only rarely been used in the family (Denton 1978, Wilson 1981a), but is very useful diagnostically and gives a precise idea of frequency of glumes along the rachilla. It is clearly defined even on bare rachillas by the attachment scars and hence easy to measure. Glume spacing ranges from as low as 0.5 mm in specimens of *C. holoschoenus* to as high as 4.7 mm in *C. cunninghamii*. Each species has a characteristic range although there is minor intraspecific variation.

As flowers mature, glumes are generally spread farther from the rachilla. This is obviously mechanically influenced by the swelling of the ovary to form the mature nut in many cases, but in some cases the glumes remain close to the rachilla at maturity (or even enclosing the rachilla as in *C. cunninghamii* subsp. *uniflorus*). The

degree of spreading of the glumes is generally slightly exaggerated in the drawings of spikelets in this paper, that is, the rachilla is mostly not so visible. Spikelet width is measured across the flat face of a mature spikelet between two imaginary lines drawn parallel to the rachilla through the glume apices.

Glumes

Features of the glumes important in species recognition in section *Pinnati* include: glume shape, size, nervation, colour, and apex and margin details, also glume spacing. As mentioned before, the glumes are at least somewhat compressed laterally producing laterally flattened spikelets, except in *C. cunninghamii*, in which they are often round in cross-section, enclosing the nut and forming a terete spikelet.

Since glumes are usually flattened and most readily viewed laterally, most of their features are described as seen in side view: shape, width, lateral nerve number, angle of the mucro. Thus, glume width refers to the distance from the midrib to the margin (measured at the broadest point of the glume). Lateral nerves are so generally 2–4 per side that this feature is of limited diagnostic value.

The midrib is produced in a mucro, generally short, which may continue the line of the midrib (and then termed *straight*) or may be *excurved*, or rarely *incurved* (in *C. orgadophilus* and *C. sporobolus*). Measurements are given both for mucro length and for glume length *including mucro* since many species have such a short mucro that it can be difficult to accurately measure the mucro separately. The midrib itself may be straight or curved as seen in side view. It is straight (or only slightly curved) in most taxa, but in some it is markedly curved so as to give a convex appearance to the glume mid-region, as in *C. holoschoenus*, *C. sporobolus* and *C. cracens*. The midrib is also markedly curved in *C. cunninghamii* subsp. *cunninghamii* and *C. ixiocarpus* but in a concave fashion.

The midrib is always at least slightly thicker in texture than the sides of the glume but it is markedly so in *C. latzii* and *C. ixiocarpus*. The midrib is smooth in all species except *C. cracens* and *C. portae-tartari*, in which it may occasionally bear prominent prickles reminiscent of those found in the American section *Glutinosi* and also in *C. renschii* Boeck. (sect. *Diffusi*). Occasionally, the midrib in *C. holoschoenus* is scabrous towards the apex.

Glume (and therefore spikelet) colour is useful diagnostically, despite the occasional exception because of abnormal growing conditions. The midrib in all species is initially green, eventually becoming dull brown with maturity. The body of the glume may be stramineous, bright yellow, golden brown or red-brown. In some species, description is complicated by the presence of yellow or red-brown blotches on a pallid background, which may alter with maturity to a more even coloration.

The actual margins of glumes usually differ in texture from the main body of the sides. Most species have hyaline or pallid, thin-membranous margins. The degree of inrolling of the margins (as well as width of rachilla wings) determines whether the nut is clasped by the subtending glume and therefore falls with it as in, for example, *C. carinatus* and *C. cunninghamii*, or whether the mature nut falls separately from the glume as in *C. angustatus* and *C. crispulus*. Nuts in species with viscid spikelets may also fall with the glume; in *C. ixiocarpus*, for example, the rachilla is mostly narrowly winged and the glume margins are not inrolled, but viscid secretions ensure that nut and glume fall together.

Stamens

In section *Pinnati*, stamens are uniformly three in all flowers examined, although Domin (1915) reported two in *C. cunninghamii* (q.v.). As in the rest of the family, anthers are basifixed and introrse, opening by a longitudinal slit. They are borne on thin, strap-like, free filaments that elongate greatly at anthesis. Anther colour ranges from yellowish to reddish, varying with degree of maturity. In some species, such as *C. microcephalus*, the connective is produced in a fragile, reddish apical appendage. Because of the likelihood of at least portion of the appendage being broken off, separate measurements are given for mature anther and appendage length.

Styles

In section *Pinnati*, as in much of *Cyperus* sens. lat., styles are 3-fid, with the branched portion mostly as long as the unbranched portion. Differences are not diagnostically useful.

Nuts

Nut shape, size, colour, apex and surface tend to be species-specific and hence are given in detail in the descriptions. As with the glumes, the nut outline and apex are described in two-dimensional terms, qualified by *trigonous* or *triquetrous*, and with an indication of whether faces are *flat*, *concave* or *convex* to give a composite picture of nut shape. In most species, the nut is occasionally slightly asymmetrical because of pressure from the rachilla and/or glume during growth. This has not been mentioned in descriptions.

Nut diameter and length, in absolute terms and relative to glume length, are given in the descriptions. In most species the nut is shorter than the glume, but in some, e.g. *C. angustatus* and *C. crispulus*, the nut exceeds the glume and is a prominent feature of the mature spikelet. Mature nut colour ranges from pale yellowish brown to red-brown or black.

The nut surface as seen under the dissecting microscope is described in the following terms:

shining, if the surface has an even smooth gloss; *glistening*, if the surface reflects light so that it appears to twinkle; *tuberculate*, with small widely spaced elevations; *colliculate*, with broad rounded elevations completely covering the surface; *foveate*, pitted; *smooth and reticulate-areolate*, the surface more or less smooth or flat (at least at low magnifications), with the cell outlines obvious as a network of fine lines.

These surface conditions depend on the size of the silica body within the epidermal cells and the curvature of the outer periclinal walls of the cells (see below for details).

The last feature mentioned in descriptions is whether the nut falls as a unit with the glume or separately from it. As mentioned above, they may fall as a unit because of inrolled glume margins, broad rachilla wings, or viscidity of the spikelet.

SEM study of the nut epidermis

Introduction

The achene or nut found in most species of Cyperaceae is small and relatively uniform, offering few easily observable macro-morphological surface features. Earlier studies have concentrated on anatomical features of the pericarp visible by light microscopy, particularly the silica bodies in the epidermal cells and the mesocarp layers of sclerenchymatous fibres (Menu 1908, Marek 1958). Federowicz (1962) used plastic replicas of the surface in studying North American *Cyperus* species.

The earliest SEM study of nuts in this family was of North American species of *Scirpus* sens. lat. and related genera by Schuyler (1971). He pointed out that more interesting features were visible if one stripped off the outer periclinal walls of the epidermal cells (in an ultrasonic cleaner or by using an acetolysis mixture) to expose the anticlinal walls and silica body (if present) on the inner periclinal wall. Studies have found little variability within a species or subspecies (e.g. Toivonen & Timonen 1976, Piperno 1989).

The only study published on a group of *Cyperus* species is of the C_3 section *Luzulae* (Denton 1983). Numerous species of *Cyperus* sens. lat. have been examined by Wilson and Johnson (unpubl.) as part of their study of generic limits in tribe Cypereae. As in other genera, the most significant features taxonomically have been found to be: size and shape of cells; shape and sculpturing of silica bodies; number of anticlinal walls per cell; and presence or absence of buttresses connecting the silica body to the anticlinal cell walls.

Silica is commonly deposited in cells of grasses and sedges, in a hydrated amorphous form polymerised from monosilicic acid, which is absorbed by the roots from soil solution (Raven 1983). The deposits may form either discrete bodies or thin layers conforming to the shape of the cell-walls. The bodies are usually called silica bodies or aggregates (Sangster & Parry 1981) or phytoliths (Piperno 1989). Their surface detail can be seen with the SEM after treatment to remove the outer periclinal cell-walls (e.g. Le Cohu 1973, Gordoń-Gray et al. 1978).

In the Cyperaceae, the discrete bodies have a flattish base of an area corresponding to that of the inner periclinal cell-wall, with one or more relatively large, more or less conical bodies seated on that base and projecting into the lumen of the cell. The bodies may show various secondary sculpturing. Development of the bodies in *Cyperus* has not yet been investigated but Ragonese et al. (1984) describe similar silica bodies in *Rhynchospora* as beginning as a basal pad on the inner periclinal wall and 'growing' in a more or less conical shape into the lumen as more silica is deposited. There is greater interspecific variation in form in fruits than is found in vegetative parts (see below).

Survey of section *Pinnati*

Methods

Mature nuts were examined intact, or were soaked in an acetolysis mixture (9:2 acetic anhydride : sulphuric acid) for 1–6 hours, after which the outer periclinal walls either floated off as a complete layer or could be gently removed with forceps. The nuts were then stored in absolute alcohol until wanted for examination with the light or scanning electron microscopes. For SEM examination, they were air-dried for a few minutes before mounting on stubs. Most samples were gold-coated before being observed and photographed in the SEM. Two machines were used: a Cambridge Stereoscan S4-10 at the University of New South Wales and an ISI-40 at the Royal Botanic Gardens (the latter had lower resolution than the former).

The standard observation point was about midway along the length of the nut.

Features of epidermal layer

Features that were observed in the species of this Section include: nut surface; cell shape and size as seen in surface view; sinuosity and thickness of anticlinal walls; and silica body shape, including apex shape, and secondary ornamentation of the body and base.

Nut surface. Four patterns were found: (i) outer periclinal wall convex or inflated, and silica bodies not as tall as the anticlinal walls, (ii) periclinal wall flat and the surface

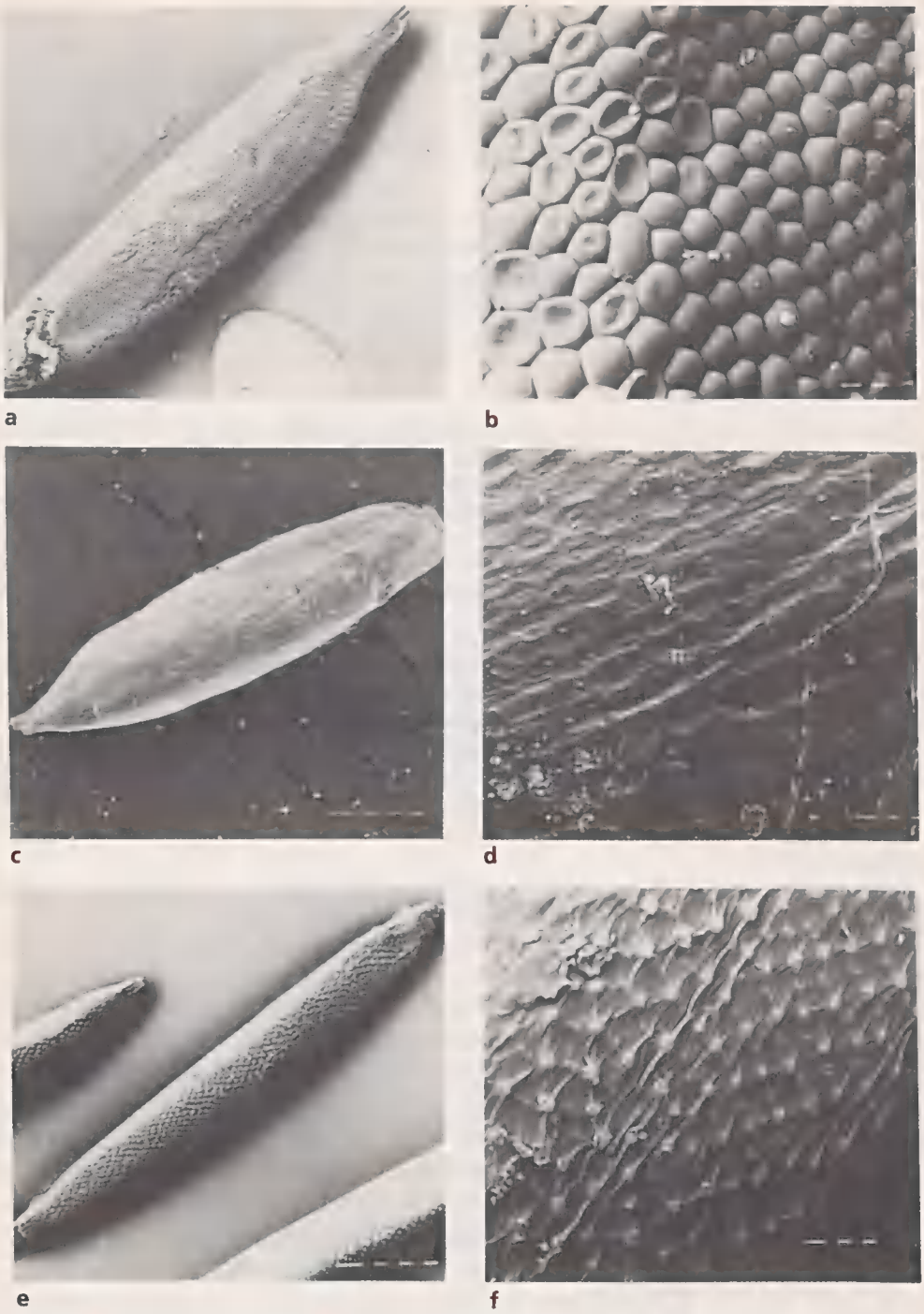


Figure 2. Nut surface types in species of section *Pinnati*. **a**, **b**, Colliculate surface of *C. betchei* subsp. *commiscens* (note some cells with concave outer periclinal walls: a presumed artifact); **c**, **d**, more or less smooth, reticulate-areolate surface of *C. holoschoenus* (smooth as seen under dissecting microscope); **e**, **f**, tuberculate surface of *C. cunninghamii* subsp. *uniflorus*. Scale: a, X 35, b, X 270 (from *Latz 7090*); c, X 37, d, X 250 (*Wilson 5331*); e, X 37, f, X 260 (*Dunlop 5842*). [Scale bar (left-most bar on micrographs from the ISI-40 SEM) = 100 µm when followed by three dashes; = 10 µm when followed by two dashes.]

nearly smooth (mostly with slightly uneven surface), silica bodies not as tall as the anticlinal walls, (iii) periclinal wall collapsed but draped over a silica body that is taller than the anticlinal walls, and (iv) periclinal wall sunken within the anticlinal walls of each cell without a tall silica body to support them.

These four patterns correlate with the surface morphology as seen with the dissecting microscope. Pattern (i) corresponds to the surface description *colliculate* (Figure 2a, b), pattern (ii) to *smooth and areolate-reticulate* (Figure 2c, d), pattern (iii) to *tuberculate* (Figure 2e, f), and (iv) to *foveate* (Figure 3a, b). Nuts with convex outer periclinal walls (that is, a colliculate surface) sometimes had a few walls collapsed but this appeared to be an artifact of observation in a vacuum; it did not correspond to the foveate or tuberculate surfaces found in other species.

The full extent of variation within species is not known since no more than four samples per species were examined. There was some intraspecific variation, particularly between having convex or more or less flat outer periclinal walls, so that these cannot be regarded as fully resolved characters yet. Some of the variation seen may be due to the different resolutions of the SEMs used; this was not investigated.

Cell shape. Most species have isodiametric epidermal cells (Figure 3c) as seen in surface view. Although predominantly 6-sided, the cells on any nut can vary from 4- to 7-sided, with a tendency to more elongated cells at the extremities of the nut. In a few species, e.g. *C. crispulus* and *C. cunninghamii*, the cells are usually elongated along the longitudinal axis of the nut (Figure 3d). Most taxa were uniform in their cell shape. However, there was some variation between samples of *C. rigidellus*, a species that is morphologically variable.

Cell size. Cell size (as seen in surface view) is rarely uniform on any one nut: generally a range of sizes is present. Largest are the elongate cells of *C. cunninghamii* and *C. dactylotes*, which range from 25 μm to 50 μm along their long axis (c. 10–15 μm across the short axis). The largest isodiametric cells are found in *C. isabellinus* (30–50 μm). The smallest cells are found in *C. oxycarpus* (12–20 μm).

Sinuosity and thickness of anticlinal walls. A few taxa have markedly sinuate anticlinal walls, e.g. *C. oxycarpus* and *C. holoschoenus* (Figure 3c). Some, such as *C. perangustus*, have slightly sinuate walls (as seen at about 300X), but more than half the taxa have straight anticlinal walls. A few species show variation in this character (e.g. *C. portae-tartari*, *C. holoschoenus* and *C. lhotskyanus*). These walls are generally thin, but are somewhat thickened in *C. latzii*, *C. viscidulus* and *C. clarus* (Figure 3e).

Silica bodies. All taxa have silica bodies in the epidermal cells, as in the vegetative parts. Each cell has one main central body per cell, more or less conical and with its base covering the inner periclinal wall. The lateral faces of the central body range from concave to plane. This, allied with the truncate, broadly acute or concave apex, produces bodies that can be likened to mesas (Figure 3f), cones (Figure 4a) and volcanoes (Figure 4b). In the mesa-like bodies, the lateral faces tend to narrow towards the middle and then spread near the apex (i.e. the body often has a 'waist').

Most taxa have a central body that is small in basal area relative to the cell lumen, with concave or plane faces sloping down to the more or less flat base, so that the erect body is obviously isolated on the cell's inner periclinal wall (Figure 3d). However, in a few taxa, e.g. *C. perangustus* (Figure 4c, d), the central body is large and covers the entire periclinal wall.

The apex of the body ranges from *broadly acute* (Figure 4a) to *truncate* (Figure 3f), *concave* (Figure 4b) or even *coronate* with several to numerous linear processes diverging from the small-circular apex (Figure 4c, d). In most taxa the apex is truncate, often with a

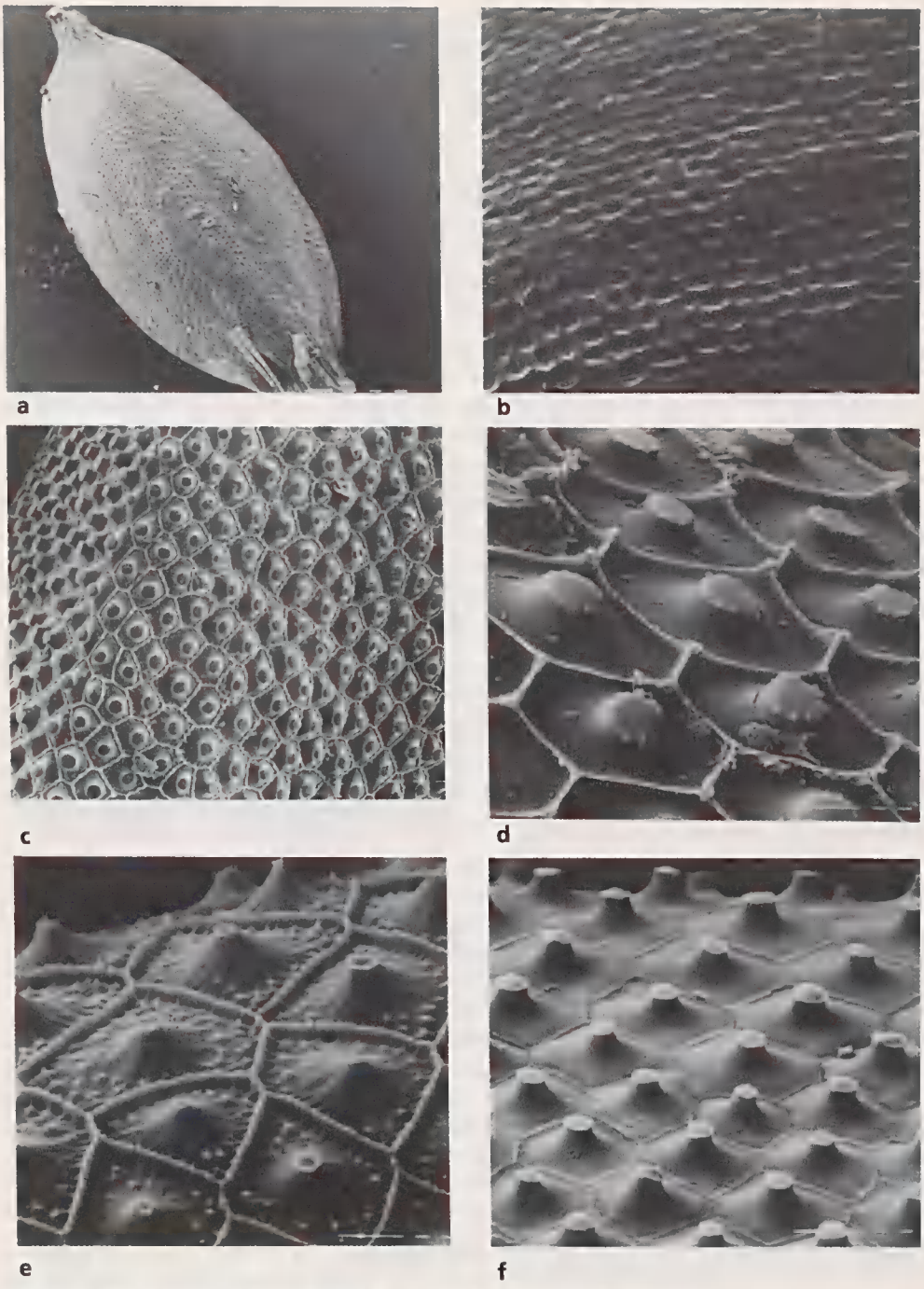


Figure 3. Nut surface types (cont.). **a**, **b**, Foveate surface of *C. viscidulus*. Features of nut epidermal cells, as seen with outer periclinal cell-wall removed. **c**, Isodiametric cells with sinuate anticlinal walls, *C. holoschoenus*; **d**, elongated cells with straight anticlinal walls and central silica body that is small in area compared to the cell lumen and has a fringed apex, *C. cunninghamii* subsp. *cheradicus*; **e**, cells with thickened walls and buttresses, *C. clarus*; **f**, mesa-like silica body with broad flattened apex, *C. dactylotes*. Scale: a, X 35, b, X 180 (*Beauglehole 47687*); c, X 200 (*Wilson 5331*); d, X 920 (*Wilson 5495*); e, X 1750 (*Wilson 4326*); f, X 920 (*Latz 5126*). [Scale bar (left-most bar on micrographs from the ISI-40 SEM) = 10 µm when followed by two dashes.]

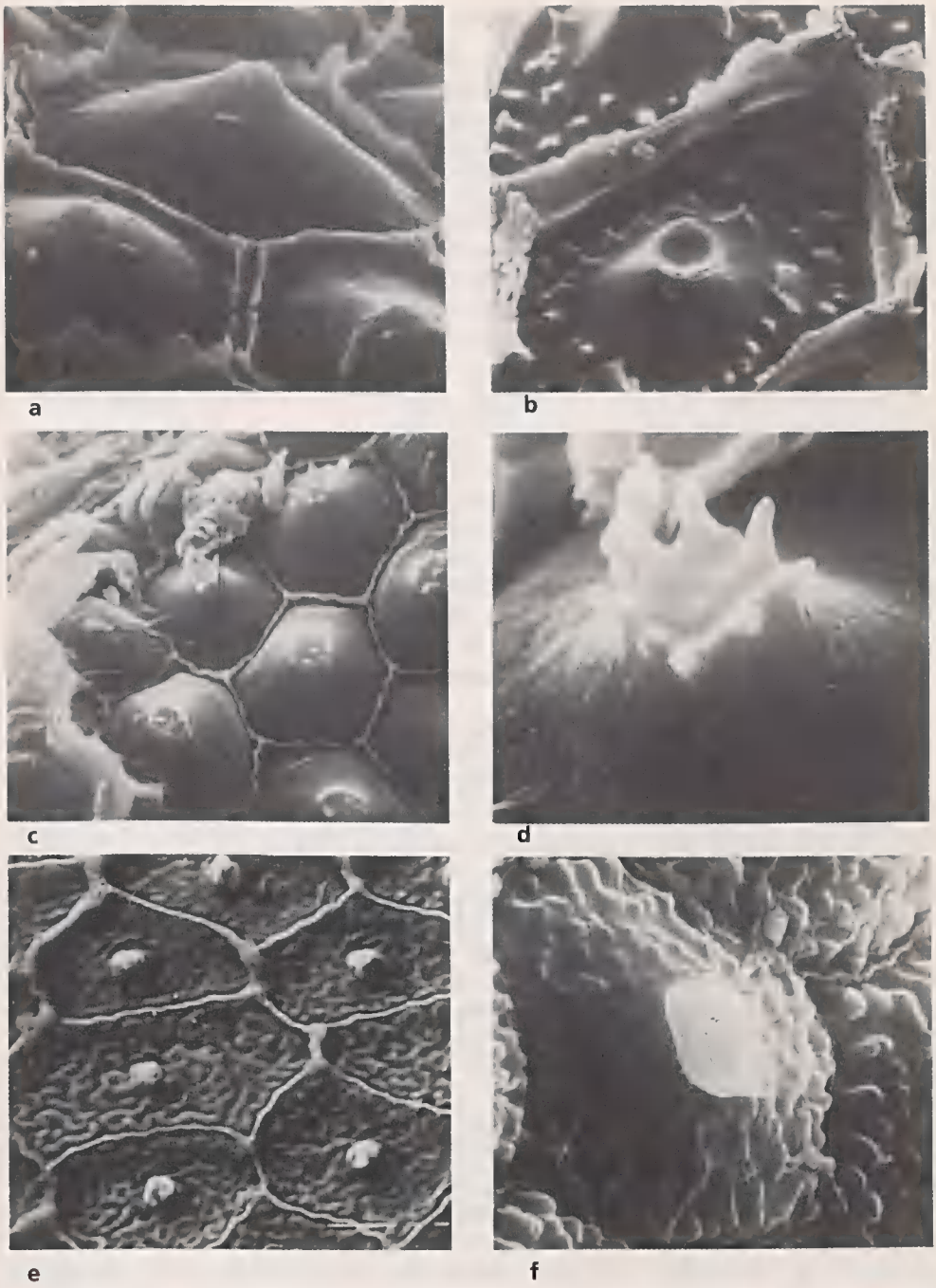


Figure 4. Features of nut epidermal cells, as seen with outer periclinal cell-wall removed. **a**, Conical silica body with broadly acute apex and smooth surface, *C. lhotskyanus*; **b**, volcano-shaped silica body with concave apex and with tuberculate secondary ornamentation, *C. fulvus*; **c**, **d**, large silica body filling cell lumen, with coronate apex, *C. perangustus*; **e**, small central silica body with rugose secondary ornamentation on base, *C. centralis*; **f**, large body with flat apex (obscured by charging) and papillate secondary and tertiary ornamentation, *C. ixiocarpus*. Scale: a, X 4000 (*Beauglehole 49697*); b, X 3900 (*Coveny 3916*); c, X 1900, d, X 9000 (*Blake 11304*); e, X 940 (*Latz 2134*); f, X 3900 (*Latz 6698*). [Scale bar (left-most bar on micrographs from the ISI-40 SEM) = 10 μm when followed by two dashes; = 1 μm when followed by one dash.]

fringe of minute processes spreading laterally (e.g. in *C. cunninghamii* subsp. *cheradicus* (Figure 3d)).

Secondary ornamentation was mostly observed at about 200–600X magnification. There was some evidence of further ornamentation being visible at even higher magnifications, such as the 'papillae on papillae' in *C. ixiocarpus* (Figure 4f). The surface of the silica body and its base varies from *smooth* (Figure 4a) to *rugose* (Figure 4e), *papillate* (Figure 4f) or *tuberculate* (Figure 4b). Smooth surfaces are most common but secondary sculpturing is found in some taxa, often only on the base. Smooth central bodies with a rugose base are found in a few species, such as *C. crispulus* and *C. microcephalus*, and with a tuberculate base in *C. fulvus* (Figure 4b). Only *C. viscidulus* and *C. clarus* (Figure 3e) show what Denton (1983) terms *buttresses*: strong ridges connecting the anticlinal walls and the basal part of the silica body.

Discussion

The nut characters discussed above show promise of being useful taxonomically at the species level, as Denton (1983) found with *Cyperus* section *Luzulae*, or in delimiting subgroups of related species, e.g. *C. fulvus*, *C. gilesii* and *C. clarus*. However, the full extent of intraspecific and developmental variation needs to be determined before these characters can be used with confidence in this group. Coronate apices, for example, may be an elaboration of the fringed flattish type; both can certainly be found in the same taxon (e.g. *C. carinatus*) although not on the same nut. Similarly, conical bodies are only found in species of which other specimens have mesa-type bodies and hence may only represent an early stage of development of the body.

Vegetative anatomy

Materials and methods

Fresh leaf and culm material was used for sectioning whenever available, but mostly samples from dried herbarium specimens were used, after boiling up in water with a few drops of detergent. Most sections were cut by hand with a razor blade, a few were done on rotary or sledge microtomes. Some sections were stained with toluidine blue, but most were not stained as the main interest lay in the tissue patterns and these were readily visible without staining. As part of the general survey of *Cyperus* sens. lat., sections (mainly of leaves) had been cut previously for many species and these were useful for comparative purposes. Metcalfe's (1971) anatomical survey of the family Cyperaceae provided a good basis for terminology and comparison. Druyts-Voets' survey (1970) of *Cyperus* species (mainly those in subgenus *Cyperus* sensu Kükenthal) was also useful.

Culm sections were cut about halfway along the length of the culm. Leaf sections were cut about halfway between the lamina base and the apex. Multiple sectioning of a few species established that species are generally consistent in their anatomical patterns as long as comparably mature samples are chosen. If, however, one compares an immature with a more mature leaf, there may be differences. For example, a senescent and an immature leaf from the same tuft of a specimen of *C. orgadophilus* were sectioned and showed differences in outline and in development of bulliform cells and adaxial subepidermal sclerenchyma strands. For most species, only one or two sections (from mature leaves and culms) were cut. Features were tabulated for all taxa, as well as for a few other species of *Cyperus* for comparison (Tables 1, 2). Representative sections were drawn using Metcalfe's (1971) conventions for shading of tissues.

Features common to culms and leaves

Epidermal cells are smaller over sclerenchyma strands in both leaves and culms, and mostly contain silica bodies, which are conical as seen in cross-section, with the base resting on the inner periclinal wall. This is in contrast to the variety of shapes seen in silica bodies in nut epidermal cells (page 373). The number of silica bodies per cell varies from one to four, all in a single row so far as seen.

Stomates are found only on the abaxial surface of the leaf. Mature stomates are paracytic in Metcalfe's terminology (brachyparacytic, Dilcher 1974), i.e. with the guard cells each laterally in contact with one subsidiary cell but the polar regions of the stomates in contact with the ordinary epidermal cells. The cuticle varies little and hence is not described.

Vascular bundles are collateral, and chlorenchyma is radiate around the bundles. This is characteristic of the anatomy termed Kranz (see, e.g. Brown 1975), which is correlated with the C_4 type of photosynthesis (see page 391 for further discussion).

The distinctive arrangement of vascular bundles and associated bundle sheaths and radiate chlorenchyma around large air-cavities in both leaves and culms is of Metcalfe's *Mariscus* A-anatomy type or modifications thereof (Figures 5–7). This arrangement is also found in species of sections *Glutinosi*, *Thunbergiani* and *Turgiduli*. There are small commissural (cross-connecting) vascular strands in the air-cavities in some cross-sections, apparently linking up to six of the vascular strands around an air-cavity.

Leaf T.S.

The leaves are dorsiventral, that is, all vascular bundles have the same orientation, and the adaxial epidermis is distinguishable from the abaxial epidermis. The leaves of all species are triangular if sectioned near the apex, and broadly U-shaped or crescentiform towards the sheath region (Figure 5).

Outline of leaf cross-sections. The outline at the halfway point ranges from *broadly V-shaped* (Figure 5c) to *thickly crescentiform* (Figure 6a), which correlates with the prominence of the midrib. It is often slightly asymmetrical, especially in the species with more crescentiform cross-sections (e.g. *C. blakeanus* and *C. secubans*).

The outline is generally smooth, but is somewhat uneven in various species, which correlates variously with raised or sunken stomates (e.g. *C. astartodes*, *C. secubans*) or position of sclerenchyma strands (e.g. *C. carinatus*, *C. cunninghamii*, *C. holoschoenus*) or unevenly thickened cuticle (*C. crispulus*). All species have marginal prickle hairs, which may or may not be seen in a T.S.; these have not been tabulated but are included in each species' description. Some species (especially *C. microcephalus* and *C. portae-tartari*) may occasionally be scabrous on the abaxial surface as well.

Epidermis. The cells of the adaxial epidermal layer range from only slightly larger than to twice as large as those of the abaxial layer (which accords with Metcalfe's definition of A-anatomy). In most of the species, the adaxial cells are about twice as large but they are nearly the same size in some specimens of *C. gunnii* and *C. alterniflorus*. In all taxa the epidermal cells are smaller over sclerenchyma strands.

Bulliform cells. These are present in the midrib region of the adaxial epidermis in about two-thirds of the cross-sections. In general, species characteristically either possess or lack bulliform cells, but in some species (e.g. *C. betchei* and *C. fulvus*) both conditions occur, as suggested by Metcalfe (1971). In at least some species there is variation with stage of growth: they were absent from a young leaf of *C. orgadophilus* (*Wilson 5373*) but present in a fully elongated leaf from the same plant. In a specimen

Table 1. Anatomical features of leaves, as seen in cross-section, of species in *Cyperus* sect. *Pinnati*. Examples from various other Sections are included for comparison.

Species	1	2	3	4	5	6	7	8	9	10
Sect. *Pinnati*										
cunninghamii										
ssp. *cunninghamii*	c	+	-/+	-/1	na/+	1-6	2	cd	2	-
ssp. *cheradicus*	c/v	+	-	-	na	3	2	c	-	-
ssp. *cheradicus* (young leaf)	v	+	+	1	+	1	2	c	2	+
ssp. *cheradicus* (old leaf)	v	+	+	2	-	1-2	2-3	cd	2	+
ssp. *uniflorus*	v	+	+/-	1-2/-	-/na	2	1-2	c	2	+
astartodes	c/v	+	-	1	+	1	2	c	2	-
hesperius	c/v	+	-	-	na	2-8	1-2	cb	2	+/-
microcephalus										
ssp. *microcephalus*	v	+	+/-	1-3	-	1-3	1	cb	2	++
ssp. *chersophilus*	ac	+	+/-	-/1-2	na/+	1-2	1-2	cb	1	-/+
ssp. *saxicola*	ac	+	-/+	-/1	a/+	1-5	1	cb	-/1-2	-
crispulus	ac	+	-/+	-	na	1-9	2-3	cd	1-2	-
sexflorus	v	+	-	1	+	1	1-2	bc	2-3	+
portae-tartari	v	+	-	1-2	+/-	1-2	2	cb	2-3	+/++
cracens	ac	+	+/-	-	na	1-4	2-3	c	2	-/+
sporobolus	ac	+	-	-	na	2-4	2	c	2	+/-
orgadophilus (young leaf)	ac	+	-	-	na	1-3	3	cd	2	+
orgadophilus (old leaf)	v	+	+	1	+	1-2	2-3	c	2	+
blakeanus	ac	+	-/+	-	na	2-5	2	cb	1	-
angustatus	ac	+	-	-	na	2	3	cd	2	-
ixiocarpus	c	+	-	-	na	5-9	2	cd	2	-
viscidulus	v	+	-/+	1	-	2	2	bd	2	+/-
carinatus	v	+	+	2	-	2-3	2-3	cd	2	+
holoschoenus	c	+	-	-	na	1-3	3	cd	2	+/-
oxycarpus	c	+	+	1	-/+	1-4	2	d	2	+/-
betchei										
ssp. *betchei*	c/v	+	+	1/-	-/na	1-2	2-3	c	2	+/-
ssp. *commiscens*	v	+	+	2	-	1-4	2	cd	3	+/-
dactylotes	v/c	+	+	2	-	1-3	2-3	c	1-3	+
fucosus	c	+	-	-	na	1-4	2-3	d	2	+/-
gunnii										
ssp. *gunnii*	v	+	+	-/2	na/+	1-3	3-4	cd	1-3	+/-
ssp. *novae-hollandiae*	v	+	+	2	-/+	2-3	3	c	4	++
alterniflorus	v	+	+	1-2	-	2-3	3-4	c	2-4	++
lhotskyanus	c/v	+	+	1	+/-	1-4	3-4	cd	2-3	-
centralis	v/c	+	+	1	-	1-2	2	cd	2	+/-
secubans	ac	+	-	-	na	3-11	2-3	c	(2)	-
isabellinus	v	+	+	1	-	1	2	cb	2	+
rigidellus	c	+	-	1-2	-	1-2	2	cbd	1-2	-/+
clarus	v	+	-	1-2	-	1	1-2	cb	1-2	+
fulvus	v	+	+/-	1/-	-/na	1-2	2-3	cbd	1-2	+
perangustus	v	+	+	1	- -	1	2	b	2	++
gilesii	v	+	-	1-2	-	1	1	bd	2	+/-
latzii	v	+	-	1/-	+/na	1	2	c	2	+

Species	1	2	3	4	5	6	7	8	9	10
Sect. *Glutinosi*										
elegans	v?c	+	-/+	-	na	4-7	2-4	d	-/2	-
oxylepis	c	+	+	-	na	4-6	2-3	d	-/2	-
rubiginosus	v	+	+/-	-/1	na/+	1-2	1-2	bd	2	+
trachysanthos	c	+	-	-	na	3-7	2-3	d	3	-
Sect. *Subquadrangulares*										
tenuiculmis	v	+	+	1	-	-	na	s	3	++
Sect. *Thunbergiani*										
lucidus	v	+	++	3	-	2-3	1-2	cb	2	++
Sect. *Turgiduli*										
conicus	v	+	++	1	-	2-3	1-2	bd	1	+

Column 1. Shape in outline: a, asymmetrical; c, crescentiform; v, V-shaped.

Column 2. Epidermal cells over sclerenchyma strands: +, smaller; - , same size as other epidermal cells.

Column 3. Sclerenchyma strands: +, present immediately beneath adaxial epidermis; -, absent from that position.

Column 4. Number of layers of bulliform cells.

Column 5. Bulliform cells: +, raised relative to adjoining epidermal cells; -, level; - -, depressed.

Column 6. Number of layers of hypodermal cells.

Column 7. Number of vascular bundles per girder.

Column 8. Arrangement of vascular bundles (i) around air-cavities: c, completely encircling cavities; b, abaxial layer incomplete; d, adaxial layer incomplete; (ii) in single row: s.

Column 9. Number of sclerenchyma strands associated with midrib.

Column 10. Midrib: +, obvious anatomically; -, not obvious.

Table 2. Anatomical features of culms, as seen in cross-section, in species of *Cyperus* sect. *Pinnati*. Examples from various other Sections are included for comparison.

Species	1	2	3	4	5	6	7
Sect. *Pinnati*							
cunninghamii							
ssp. *cunninghamii*	tg	f/r	+	t,bt	-	+	o
ssp. *cheradicus*	tg	f	+	t,o	-	+	o
ssp. *uniflorus*	tg	f/r	+	so,bt	-	+	o
astartodes	tg	f	+	tt	-	+	o
hesperius	tg	f	+	t	-/+	-	o
microcephalus							
ssp. *microcephalus*	tg	f/s	+	tt	+/-	+	o
ssp. *chersophilus*	tg	f	+	t	-	+	o
ssp. *saxicola*	t	f	+	t,bt	-	-	o
crispulus	tg	f	+	tt	-	-	o
sexflorus	tg	f	+	tt,t	-	+	o
portae-tartari	g	f/r	+	t,so	+/-	+	c
cracens	gt	f	+	t,bt	-	+	o
sporobolus	tg	f	+	t,bt	-	+	o
orgadophilus	tg	f	+	t	-	+	o
blakeanus	gt	f	+	bt	-	+	o
angustatus	tg	f	+	o	-	+	o
ixiocarpus	t	f	+	tt,t	-	+	c
viscidulus	gt	f	+	t	-	+	o
carinatus	gt	f	+	bt	-	+	c
holoschoenus	gt	f	+/-	o	-	+	c
oxycarpus	g	f	+	tt	+/-	+	o
betchei							
ssp. *betchei*	gt	f	+	tt	-	+	o
ssp. *commiscens*	gt	f/s	+	o	-	+	o
dactylotes	tg	f/s	+	o	-	+	o
fucosus	t	f	+	o	-	+	o
gunnii							
ssp. *gunnii*	gt	f	+	t	-	+	c
ssp. *novae-hollandiae*	qg	f	+	bt,t	-	+	c
alterniflorus	qg	f	+/-	o,tt	-	+	c
lhotskyanus	gt	f	+	tt,t,o	+/-	+	c
centralis	gq	f	+	t	-	+	o
secubans	t	f/r	+	bt,t	-	+	o
isabellinus	gt	f	+	t	-	+	o
rigidellus	qgt	f	+	bt,t	-	+	c
clarus	qg	f	+	bt,t	+/-	+	o
fulvus	gqt	f/r	+/-	t,bt	-/+	+	o
perangustus	qg	f	+	t,tt	+/-	+	o
gilesii	gq	f	+	bt,t	-	-/+	o
latzii	gt	f	+	t	-	+	c
Sect. *Glutinosi*							
elegans	tg	f	+	tt,t	-	+	?c
oxylepis	tg	f	+	o,tt	-	+	c
Sect. *Subquadrangulares*							
tenuiculmis	g	f	+/-	to	-	-	o

Species	1	2	3	4	5	6	7
Sect. *Thunbergiani*							
lucidus	q	f	+	so,t	-	+	c
Sect. *Turgiduli*							
conicus	t	f/s	+	o,tt	+/-	+	c

Column 1. Shape in outline: g, trigonous; q, triquetrous; t, terete.

Column 2. Stomates relative to adjacent epidermal cells: f, flush; r, raised; s, sunken.

Column 3. Epidermal cells over sclerenchyma strands: +, smaller; - , same size as other epidermal cells.

Column 4. Shape of sclerenchyma strands: o, oblong ▮; to, transversely oblong ▬; so, short-oblong ▪; t, triangular ▲; tt, tall-triangular ▮; bt, broad-triangular ▲.

Column 5. Sclerenchyma strands: +, all about the same size; -, various sizes in the one section.

Column 6. Large peripheral air-cavities: +, present; -, absent.

Column 7. Vascular bundles in central ground tissue: o, only in outer ½ – ⅔ ; c, throughout central ground tissue.

of *C. cunninghamii* subsp. *cheradicus* (*Wilson 4894*) they were raised above the surface in a young leaf but flush with the surface in a senescent leaf from the same plant. A second layer of bulliform cells was found in about one-third of the samples (e.g. in *C. alterniflorus*, *C. carinatus* and *C. portae-tartari*); a third layer was found in one section of *C. microcephalus* ssp. *microcephalus*. The bulliform cells are generally level with the rest of the adaxial epidermis (Figure 6h–j) but they are raised in a few species (*C. astartodes*, *C. microcephalus* subsp. *chersophilus* (Figure 6e, g) and *C. sexflorus*) and, as mentioned above, their level differed in young and mature leaves of a plant of *C. cunninghamii* subsp. *cheradicus*. In *C. perangustus*, the bulliform cells are unusual in being sunken relative to the surrounding epidermal cells.

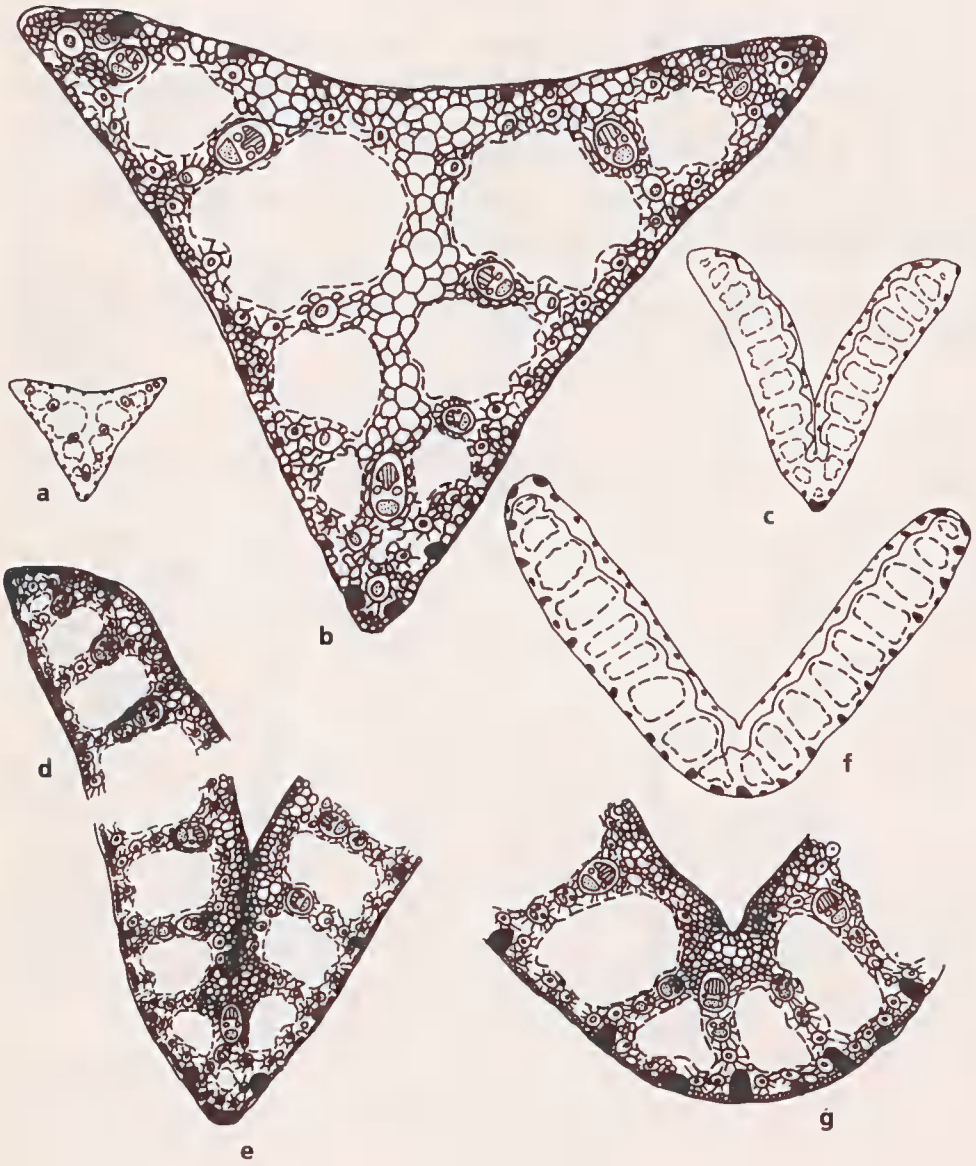


Figure 5. T.S. leaf *Cyperus gunnii*. **a**, **b**, Near apex; **c**, **d**, **e**, at halfway point; **f**, **g**, near junction of lamina and sheath. Scale: a, c, f, X 35; b, X 175; d, e, g, X 90 (from *Wilson 4422*).

Hypodermis. A hypodermis is always present beneath the adaxial epidermis, occasionally as only one somewhat discontinuous layer (e.g. in *C. rigidellus*), but usually as one to three continuous layers of thin-walled, translucent parenchymatous cells, and occasionally up to eleven layers deep in the midrib region (Figure 6a).

Sclerenchyma. All sclerenchyma is in the form of strands in Metcalfe's terminology: that is, the columns of sclerenchyma adjacent to the epidermis do not join up with the vascular bundles. There are no sclerenchyma girders (complete columns connecting the vascular bundles to one or both epidermis(es)) such as are common in other genera of Cyperaceae. In other species of *Cyperus* with air-cavities below the layer of

Figure 6. T.S. leaf lamina at halfway point. **a**, *Cyperus secubans*; **b–d**, *C. ixiocarpus*; **e–g**, *C. microcephalus* subsp. *chersophilus*; **h–j**, *C. gilesii*. Scale: a, X 90 (from *Coveny 8812*). b, X 35; c, d, X 90 (*Latz 1255*). e, X 90; f, g, X 175 (*Wilson 4891*). h, X 35; i, j, X 175 (*Milthorpe & Cunningham 1725*).

vascular bundles, mechanical strength is maintained by having very large vascular bundles at regular intervals spanning the width of the leaf or by having parenchymatous girders. Their place is taken in section *Pinnati* by 'girders' of vascular bundles.

Small sclerenchyma strands are always present near the margins of the adaxial surface, at the extremes of the chlorenchymatous tissue. As well, small sclerenchyma strands may be present immediately below the adaxial epidermis in the hypodermal layer (Figure 5). These strands are found in some species with narrow leaves but are more common in species with broader leaves (e.g. *C. alterniflorus, C. betchei, C. carinatus, C. gunnii*) although they are not always present then (absent from *C. astartodes, C. ixiocarpus* (Figure 6b–d) and *C. holoschoenus*).

Larger strands (which are still relatively small compared to those found in other species of *Cyperus*) are always present adjacent to the abaxial epidermis. They regularly occur below the vascular bundle girders, and generally there are one or two strands between these as well. One to four strands are associated with the midrib region.

Midrib. This is clearly defined, both anatomically and in gross morphology, in only about half the species. However, in most species the midrib region can be recognised anatomically by a combination of at least two of the following characteristics: presence of a definite keel abaxially, bulliform cells adaxially, a forked vascular bundle girder and more numerous layers of hypodermis. This region is frequently markedly eccentric in crescentiform leaves (Figures 6a, 7a).

The midrib has associated with it a modified vascular bundle girder. This may take various forms, generally based on an inverted Y shape formed by forking of the basal part of a girder abaxial to the largest (uppermost) vascular bundle in that girder. This forked vascular bundle girder is present even in thickly crescentiform leaves in which the midrib is not obvious in the outline. Often there is a secondary fork, e.g. in *C. crispulus, C. cunninghamii, C. ixiocarpus* (Figure 6b–d), *C. lhotskyanus* and *C. sporobolus.* In *C. holoschoenus,* there are two forked vascular bundle girders associated with the midrib as well as three sclerenchyma strands.

In *Cyperus* generally, the midrib has associated with it one extensive abaxial V-shaped sclerenchyma strand that follows the outline of the abaxial surface and often helps to form a definite keel. In section *Pinnati,* however, the midrib generally has one to four smaller sclerenchyma strands (not elongated laterally) associated with the forked vascular bundle girder. When there are two or four strands, the direct association with the girder is obvious. When there is one strand, it appears to be a result of two coalescing (as occurs in other Sections of *Cyperus*). When there are three strands, the eccentricity of the midrib is often further exaggerated: the central strand (between the forks of the vascular bundle girder) is smaller and one of the laterals becomes dominant, marked by a change in angle at that point of the abaxial outline and occasionally by scabrous epidermal outgrowths.

Vascular bundles. The arrangement of vascular bundles in leaf sheaths and blades of most species fits Metcalfe's *Mariscus* A-anatomy. Vascular bundle 'girders', i.e. the columns of vascular bundles lateral to an air-cavity, provide mechanical support for the leaf.

The vascular bundles are in two sizes in all leaves: one large vascular bundle sits at the top of each vascular bundle girder, while the majority of vascular bundles are markedly smaller and are found (one to three of them) abaxial to the large vascular bundle in each girder as well as along the adaxial and abaxial sides of the air-cavities. They form continous or discontinuous abaxial or adaxial layers, depending on whether the outermost ring of chlorenchymatous cells touches that of the next, or is separated from it by one or more colourless parenchymatous cells.

Metcalfe characterised his *Mariscus* A-anatomy as having continuous layers of vascular bundles around the air-cavities. However, most species in section *Pinnati* occasionally show slight modifications of that, with the vascular bundles forming incomplete adaxial or abaxial layers around the air-cavities or with air-cavities being very small. The abaxial layer may be discontinuous in, for example, *C. fulvus*, *C. clarus*, *C. isabellinus* and *C. perangustus*, while it is the adaxial layer that is discontinuous in *C. cunninghamii*, *C. fucosus*, *C. holoschoenus* and *C. oxycarpus*. In *C. gilesii* (Figure 6h–j), *C. hesperius*, *C. rigidellus* and *C. viscidulus*, both (or either) of the layers may be discontinuous. Some crescentiform leaves are small and the vascular bundles are so crowded that the pattern is not clear (there may be very few and/or very small air-cavities present). This latter condition corresponds to Metcalfe's *Mariscus* C-anatomy, which is A-anatomy with air-cavities absent or very reduced. In such species (e.g. *C. crispulus*) at least a few small air-cavities are always present (Figure 7a, b).

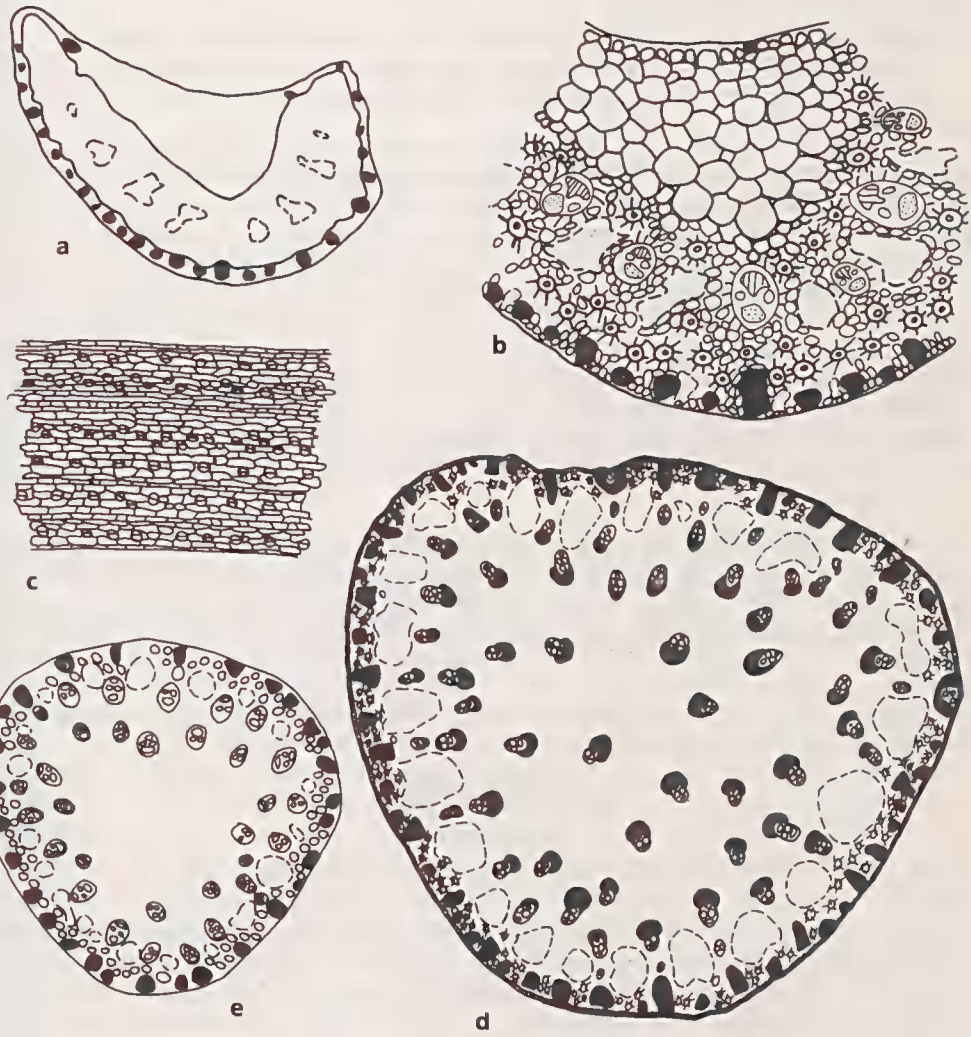


Figure 7. a, b, T.S. leaf *Cyperus crispulus*. **c**, abaxial surface of leaf *C. cunninghamii* subsp. *cheradicus*. **d**, T.S. culm *C. lhotskyanus*. **e**, T.S. culm *C. hesperius*. Scale: a, X 90; b, X 175 (from *Wilson 5303*). c, X 125 (*Wilson 5454*). d, X 25 (*Wilson 5877*). e, X 35 (*Beauglehole 11352*).

Surface view of leaf

The leaf surface in *Cyperus* generally provides few characters of taxonomic use (Metcalfe 1971). In section *Pinnati* there is no significant variation between taxa. Epidermal cells are elongated longitudinally (that is, along the length of the leaf) and stomates occur in more or less regular longitudinal bands between the vascular strands and associated subepidermal sclerenchyma strands (Figure 7c). Silica bodies are present in some epidermal cells over sclerenchyma strands; these bodies are conical as seen in T.S. and circular as seen in surface view.

Culm T.S.

The outline is trigonous, triquetrous or terete, generally smooth, but sometimes uneven because of differential sizes of epidermal cells (*C. carinatus*) or scabrous epidermal outgrowths, especially near the apex (e.g. *C. microcephalus* and *C. portae-tartari*). Some variation in outline may be due to the condition of the sectioned material or the technique used.

Generally, the stomates are flush with the cuticle surface. In a few species they may be slightly raised (e.g. *C. cunninghamii*, *C. portae-tartari*) or sunken (e.g. *C. betchei*, *C. microcephalus*) relative to the surface but some samples of such species have flush stomates.

The outer third of the culm has an arrangement of vascular bundles and air-cavities that I interpret as the A-anatomy of the leaf modified to conform with culm morphology (see figs. 7d, e). See also drawings of culm T.S. for *C. elegans* L. of section *Glutinosi* (Druyts-Voets 1970, her Figure 5A) and *C. compactus* Retz. of section *Thunbergiani* (Govindarajalu 1974, Figure 8D). Small-growing species have a crowded arrangement that, as with the leaves, can be interpreted as a compressed version of that found in larger species. The number of vascular bundles in a vascular bundle girder is comparable to that seen in leaves, although often one more or less (e.g. up to five per culm girder but only three or four per leaf girder in *C. gunnii*). Peripheral air-cavities are always present, although they are very small in some of the species with culms of small diameter, especially *C. crispulus*, *C. gilesii*, *C. hesperius* and *C. microcephalus* subsp. *saxicola*.

As in most *Cyperus* spp., the central tissue is composed of large, thin-walled parenchymatous cells that are isodiametric in cross-section but elongated longitudinally. Some species have central air-cavities (e.g. *C. betchei* and *C. cunninghamii*), apparently due to breakdown of the central ground tissue. Such cavities occur at times in all species.

All species in section *Pinnati* have at least a few vascular bundles scattered in the central ground tissue, generally only in the outer portion (Figure 7e). However, some species have vascular bundles scattered throughout the central ground tissue (e.g. *C. lhotskyanus* (Figure 7d), *C. alterniflorus*, *C. gunnii* and *C. portae-tartari*). The outer vascular bundles in the modified A-arrangement are a mixture of small and large as in the leaves; closer to the centre the vascular bundles are more or less evenly large in size.

Sclerenchyma is in the form of oblong, transversely oblong (i.e. relative to the culm epidermis), short-oblong, triangular, tall-triangular or broad-triangular subepidermal strands. Often these are quite rounded adaxially. As in the leaves, there are no sclerenchymatous girders. The adaxial caps on the vascular bundles are often large, especially in *C. alterniflorus*, *C. lhotskyanus*, *C. oxycarpus* and *C. portae-tartari*. Some variation in size of subepidermal strands (that is, within any one cross-section) was observed in all sections examined.

Discussion

All species in section *Pinnati* (as defined here) possess A-anatomy, under my definition of the type, which is less strict than that of Metcalfe (1971). I regard the type's essential features as being (i) more than one vascular bundle per girder (except in very small leaves), (ii) presence of adaxial and abaxial layers of small vascular bundles around the air-cavities, and (iii) adaxial epidermal cells of similar size (1–2X) to the abaxial. Incompleteness of the adaxial and abaxial layers of small vascular bundles and size of air-cavities seem of less importance, considering the intraspecific variation seen in sect. *Pinnati* and in species in other Sections, such as *C. oxylepis* and *C. trachysanthos* of sect. *Glutinosi*. The physiological significance of this unusual type of anatomy is not clear: it may be related to photosynthetic efficiency (see page 391).

A-anatomy is found only in sections *Pinnati*, *Glutinosi*, *Thunbergiani* and *Turgiduli* p.p. (see further detail on page 398 et seq.). The other, and by far the most common, anatomical arrangement in *Cyperus* sens. lat. (not found in sect. *Pinnati*) of vascular bundles in a single lateral row, and with the adaxial epidermal cells much larger than the abaxial cells, was termed B-anatomy by Metcalfe. He used the term C-anatomy to describe a modification of A-anatomy in which air-cavities are much reduced or absent but I would regard this as fitting within the range of A-anatomy.

Study of many species in *Cyperus* sens. lat. suggests that A-anatomy is advanced, in line with morphological features of such species, compared to the B-anatomy and its variants found in most *Cyperus* spp. with Kranz anatomy. Anatomical variants are known (Wilson and Johnson unpubl.) that may represent intermediate stages or parallel developments, for example, some *Pycreus* species have the adaxial and abaxial epidermal cells more or less the same size (a feature of A-anatomy) although the anatomy is otherwise of the B-type.

The distinctive A-anatomy is useful in distinguishing species belonging to sections *Pinnati*, *Glutinosi*, *Turgiduli* and *Thunbergiani* from the rest of *Cyperus*. Morphological features must then be used to distinguish between these Sections. Whether this anatomy is a synapomorphy for these groups or represents parallel developments is not clear.

In various other monocot groups, such as *Juncus* sect. *Genuini* (Edgar 1964, Johnson ined.) and *Mesomelaena* (Wilson 1981b), anatomical features are distinctive for a species or for small groups of closely related species. In sect. *Pinnati*, features are indeed generally consistent within a species, given samples of comparable age and relative position (cf. the differences between immature and mature leaves of *C. orgadophilus*, Table 2). However, interspecific variation is not sufficiently great to be useful in identification at or below the specific level in this Section.

Phytochemistry

Introduction

Secondary metabolites are amongst the biochemical characters that have been used in plant taxonomic studies (Harborne & Turner 1984). Formerly thought to be waste products, secondary metabolites are now considered to have a functional role in defense, pollination, energy storage and fruit dispersal (Levin 1976, Cronquist 1977), although these roles are not yet fully understood (Gershenzon & Mabry 1983). One taxonomically interesting group is the pigments, including betalains, quinonoids, carotenoids and flavonoids (anthocyanins, and yellow and colourless flavonoids). Of these, the flavonoids have been much used, mostly at lower levels of classification. Their general usefulness at higher taxonomic levels is uncertain, although comparison of flavonoids at familial level do show differences (see, for example, Williams &

Harborne (1975) and Gornall et al. (1979)). Disagreement remains over homologies and degree of advancement of particular flavonoid types. Harborne (1980) says there is a single biosynthetic pathway for any flavonoid in any species, but others disagree: Stuessy & Crawford (1983) suggest that Harborne is correct only so far as the basic steps are concerned and that the later steps may be variously regulated. Gornall & Bohm (1978) point to a secondary trend to reduction in complexity, that is, 'simple' flavonoids may be primitive or very advanced.

Flavonoids in section *Pinnati*

Flavonoids in the leaves and inflorescences of most species of section *Pinnati* were surveyed by Harborne et al. (1982, 1985), a total of 36 samples representing 28 species and subspecies. One species of the American section *Glutinosi*, *C. oxylepis* Nees, was analysed for comparison (Harborne and Williams unpubl.).

Generally, the flavonoids in section *Pinnati* conform to the pattern found in *Cyperus* sens. lat. except that:

(i) the aurone mariscetin is much more common (in 12 species; only found in seven other species of *Cyperus*);

(ii) the flavonol-derived quercetin and kaempferol methyl ethers are more common than in *Cyperus* generally (in leaves; none was found in inflorescences); and

(iii) 7,3′,4′-trihydroxyflavones were found in four species (only found in three other species of *Cyperus*).

Flavonol methyl ethers are mostly known elsewhere from bud exudates and leaf wax deposits and are relatively rare in the monocots (Wollenweber & Dietz 1981). Correlation with exudates is not certain in this case, since two of the most viscid species in section *Pinnati* (*C. ixiocarpus* and *C. viscidulus*) were not found to contain flavonol methyl ethers. The exudates in species of sect. *Pinnati* have yet to be characterised (they are soluble in absolute alcohol but not in water).

The widespread occurrence of aurones (especially in inflorescences) is the most distinctive flavonoid feature of the family Cyperaceae, the most common aurone being aureusidin. In *Cyperus* sens. lat., three other aurones have been found: mariscetin, leptosidin, and an uncharacterised aurone in the South American species *C. reflexus* Vahl. Section *Pinnati* is distinctive in the genus in having mariscetin in twelve species. Mariscetin is otherwise only known in eight species, scattered in seven Sections (Harborne et al. 1982). Of these eight species, three are confined to Australia, four are more widespread and one, *C. oxylepis* in section *Glutinosi*, is confined to South America. The close morphological similarity between species of the sections *Pinnati* and *Glutinosi* suggests that it would be of interest to analyse other species of the latter for flavonoids.

Quinones

Quinone pigments are widespread in living organisms but individual compounds tend to have a restricted distribution, which may make them useful taxonomically (Mathis 1966). Allan et al. (1969, 1978) surveyed the roots and rhizomes of 107 Australian species in 29 genera of Cyperaceae. Quinones were restricted in their sample to about half the species of *Cyperus* sens. lat. (including *Remirea* and the three species sampled in sect. *Pinnati*), as well as one species of *Fimbristylis* and *Schoenoplectus articulatus* (as *Scirpus articulatus*). Within *Cyperus*, they sampled widely and found eleven types of quinone. The single quinone found in sect. *Pinnati* also occurred in species of other Sections. Unfortunately, as with certain other studies, the significance of these results is not clear because the vouchers could not be located with certainty in the herbarium of the Botany Department, James Cook University.

Photosynthetic types

Besides my anatomical study of all species in sect. *Pinnati*, about twelve species (the number is uncertain owing to doubtful identifications of some vouchers) have been examined either biochemically or anatomically by others (Raynal & Lerman ined., Carolin et al. 1977, Takeda et al. 1985). These studies confirm that all species in this Section possess the C_4 type of photosynthesis, as do numerous other groups within *Cyperus* sens. lat. This type is characterised anatomically as Kranz anatomy of the chlorocyperoid type (that is, with two sheathing layers around the vascular bundles: the outer a mestome sheath, the inner a bundle sheath of Kranz cells) and biochemically as NADP-ME type (Raynal 1972, 1973; Carolin et al. 1977, Ueno et al. 1988).

The C_4 pathway is strongly correlated with a set of environmental conditions different from those associated with the C_3 pathway (Ray & Black 1979): high light intensity (non-saturating light growth curves), high temperatures, and cold-sensitivity. Tolerance of salinity, low nitrogen levels and probably also efficiency of water use are other features of C_4 plants. All these conditions are generally found in the hotter and drier parts of the world.

Takeda et al. (1985) found that C_4 species of Australian Cyperaceae favoured the tropical and subtropical savannas of northern Australia and hot dry areas with summer rainfall, whereas C_3 species were more common in cooler regions with a winter rainfall maximum, a situation grossly similar to that found by Hattersley (1983) in Australian grasses. Species of section *Pinnati* are, indeed, most common in northern and central Australia (Figure 8) and uncommon in the southern winter-rainfall regions of Australia. Features such as efficient water use have no doubt been important in allowing such species as *C. cunninghamii*, *C. microcephalus* and *C. crispulus* to grow in dry, rocky habitats where the other most common herbaceous plants (in terms of numbers of individuals) are the C_4 hummock grasses, species of *Plectrachne* and *Triodia*.

The photosynthetic significance of Metcalfe's A-anatomy found in vegetative parts of species of section *Pinnati* is not known. However, a function may be postulated similar to that suggested for grasses by Hattersley (1984). In C_4 grasses, the specialised Kranz chlorenchymatous cells (the photosynthetic carbon reduction or PCR tissue) around the vascular bundles are separated from air cavities by a ring of radially arranged mesophyll (primary carbon assimilation or PCA tissue). It is thought that this arrangement helps maintain high CO_2 levels in the PCR tissue and thereby improves photosynthetic efficiency. A comparable study has not been done for *Cyperus*. However,it is postulated that A-anatomy may give maximum exposure of PCA tissue to the intercellular air-cavities while limiting contact between those cavities and PCR tissue, thereby ensuring maximum gas exchange while maintaining a high CO_2 content in the PCR tissue. This remains to be tested.

Distribution and ecology

Distribution

Most species in sect. *Pinnati* are endemic to Australia, with only three also recorded sporadically in southern New Guinea. *C. gunnii* subsp. *gunnii* has been collected once in the Bay of Islands region of the North Island of New Zealand, in about the same latitude as Sydney. Healy & Edgar (1980) regard this occurrence as adventive. A few casual introductions have been identified amongst the numerous wool-alien species in continental Europe and England (Probst 1949 – specimens identified by Kükenthal;

Ryves 1976). Generally these wool-aliens do not persist in Europe and their occurrence is of curiosity value only.

Within Australia, sect. *Pinnati* is widespread (Figure 8) in summer-rainfall regions and south-eastern Australia. There are no species in the extreme south-west of Western Australia, the Nullarbor region, rain forests and alpine regions. The few records for Cape York Peninsula probably reflect lack of collecting rather than absence. Concentrations of species are found in the Pilbara, northern and central Australia, and subtropical eastern Australia (Queensland and the northern half of New South Wales) where there is a wide range of habitats. The Pilbara is regarded as a phytogeographic refugium at the south-western limit of the summer rainfall zone and with a relatively high number of endemic taxa in its flora (Burbidge 1959, 1960). *C. hesperius* is the only species of sect. *Pinnati* endemic to the Pilbara. The map does not adequately represent the range of species found in the Pilbara: ten species occur there, but have been collected only sporadically, hence the low numbers of species per grid-square.

Ecology

The warmer and more arid regions have more species of sect. *Pinnati* than the cooler and/or high rainfall areas: only *C. gunnii* subsp. *gunnii* is found in Tasmania.

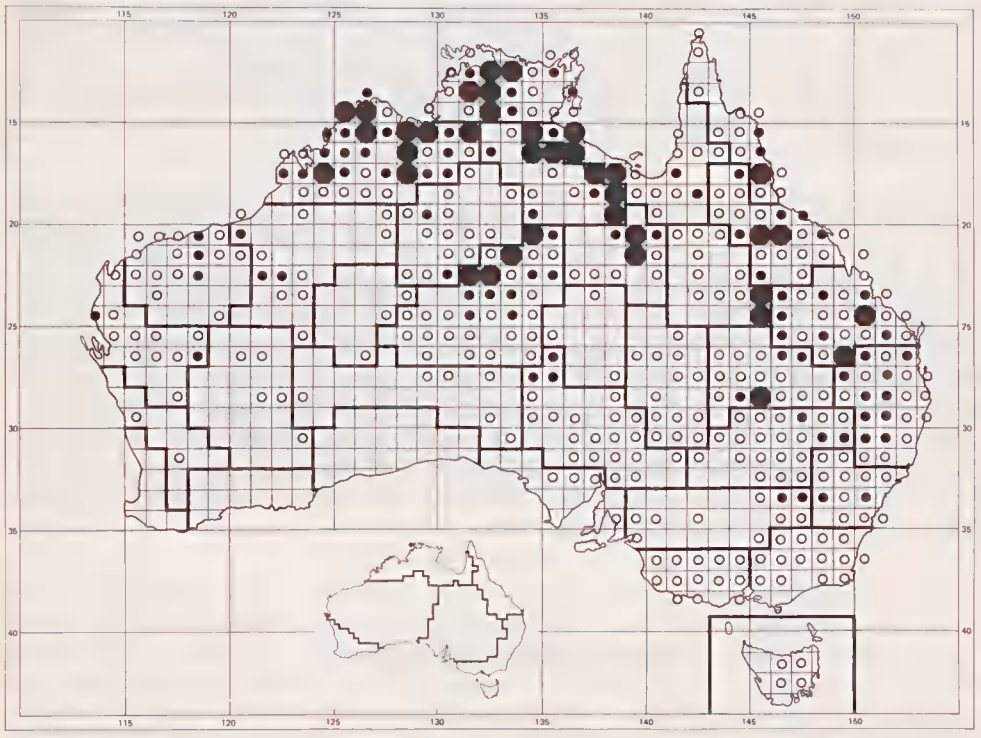


Figure 8. Number of taxa (species and subspecies) of section *Pinnati* recorded for each degree grid-square. The groupings emphasize the concentration of taxa in the Pilbara, northern and central Australia and subtropical eastern Australia. Small open circle: 1–2 taxa per grid-square; small closed circle: 3–4 taxa; big closed circle: 5–12 taxa. Base map shows natural regions of Barlow (1986).

Only *C. gunnii* subsp. *novae-hollandiae* grows in more or less permanently wet situations, on the margins of *Melaleuca quinquenervia* swamps. Other taxa grow in association with more ephemeral waters or in dryland habitats. *C. centralis*, *C. ixiocarpus* and *C. cunninghamii* subsp. *cheradicus* grow, often forming robust tussocks, in the sandy or stony beds or on the lower banks of inland streams, where they would be inundated only relatively briefly. Taxa such as *C. gunnii* subsp. *gunnii*, *C. viscidulus* and *C. alterniflorus* are similarly found on the banks of streams and billabongs, often in slightly wetter situations. The banks of man-made water supplies (roadside drains, ground tanks, gravel pits, etc.) are colonised by *C. oxycarpus*, *C. holoschoenus*, *C. dactylotes*, *C. betchei* and *C. gunnii*.

The various forms of *C. microcephalus* are all associated with dry rocky habitats: subsp. *microcephalus* on scree slopes below rock-faces and amongst boulders, subsp. *chersophilus* with hummock grasses on rocky hillsides, and subsp. *saxicola* in crevices on rock-faces and rocky outcrops. Other taxa in dry rocky habitats are *C. cunninghamii* (except subsp. *cheradicus*), *C. crispulus* and *C. astartodes*. *C. secubans* is found on rocky outcrops in the Nandewar Range of eastern N.S.W. but usually along seepage lines.

Woodland and grassland species tend to be drought-evading, i.e. the plants are capable of dying back to a basal tussock in the dry season and later shooting again. *C. orgadophilus*, *C. sexflorus* and *C. sporobolus* have definite underground bulbous bases, which may enable these species to survive the frequent fires of their tropical open forest habitat. The bases of *C. blakeanus* are somewhat bulbous: fire and seasonal water shortages are also features of the open woodland and shrubland habitats of this species. In eastern Australia, *C. fulvus* and *C. perangustus* are in forest or woodland habitats. *C. clarus* is restricted to grasslands or open woodlands on deep clay soils. *C. isabellinus* is similarly restricted to clay soils, in this case the gilgaied cracking clays associated with brigalow scrub.

C. gilesii, *C. rigidellus* and *C. isabellinus* are the only usually annual species (they may also be short-lived perennials) and they are found in the more arid and southerly inland regions. These species are capable of growing in a wide range of habitats, but usually associated with ephemeral puddles of water.

Cyperus fulvus (a woodland species) and *C. angustatus* and *C. holoschoenus* (both found in seasonally swampy sites) have been collected a few times in the southern lowlands of New Guinea. Webb & Tracey (in Walker 1972) suggest that the open sclerophyll formations of New Guinea represent a recent colonisation from Australia. Similar distribution patterns across Torres Strait are found in other families (Walker 1972), as well as in other species of Cyperaceae, e.g. *Cyperus aquatilis*, *Fimbristylis furva* and *F. recta*.

Taxonomy

Taxonomic history

The first species in this group were described by Robert Brown (1810) from material he collected at Shoalwater Bay (*C. alterniflorus*), on the East Coast of Queensland (no more specific locality given: *C. fulvus*), from North Island in the Sir Edward Pellew Group in the Gulf of Carpentaria (*C. holoschoenus* and *C. microcephalus*), from Morgans Island in Blue Mud Bay (*C. sporobolus*), in the Gulf of Carpentaria (no more specific locality given: *C. sexflorus*), and on the North Coast (probably Arnhem Bay or neighbouring islands: *C. angustatus* and *C. carinatus*). It is surprising that Brown did not

name the species subsequently published as *C. gunnii* by Hooker (1858). Brown apparently did collect a specimen of it at Port Jackson and gave it the manuscript name of *C. scaber* (Bentham 1878) but did not publish it. This would be the specimen cited by Kükenthal (1935–36) under *C. gunnii* as 'Port Jackson, *R. Brown 5924!*' but it cannot be found now in BM or K.

The majority of species occur in tropical or inland Australia so it is understandable that relatively few specimens were collected or species described after Brown's visit until well into this century. Confusion and misapplication of names has been common, as will be evident from the synonymies and notes for each species.

Poiret (1817) and Sprengel (1824) listed the species described by Brown but added no new taxa. Kunth (1837) described *C. sieberi* (= *C. fulvus*). Nees (in Lehmann 1846) misapplied the name *C. carinatus* to a specimen of *C. congestus* Vahl, apparently an introduction from southern Africa to Western Australia in the early days of that colony. He presumably did not have access to Drummond's Third Collection of specimens, which were not despatched to Hooker until August 1844 (Erickson 1969: 168). This collection included a specimen of *C. alterniflorus*, the only species of sect. *Pinnati* found in south-western Western Australia (and then only on the north-eastern fringe of that region). *C. alterniflorus* had been described by Brown from Queensland, at the opposite end of its distribution. This western specimen, *Drummond Coll. III no. 335*, was the basis of Steudel's *C. pictus* (1854). Steudel apparently had not seen material of any of Brown's species since he included them in his section of 'Species quoad sectiones priores partim omnino dubiae'.

Hooker (1858) described *C. gunnii*, the only species found in Tasmania. Boeckeler described several new species from specimens sent to him by Mueller and Amalie Dietrich: *C. novae-hollandiae* (1870; now regarded as a subspecies of *C. gunnii*), *C. ochroleucus* (1875; = *C. fulvus*) and *C. lhotskyanus* (1884). These species and previously described species of this group (*C. sieberi*, *C. angustatus*, *C. carinatus*, *C. gunnii*) were scattered amongst four of his nomenclaturally informal and rather uncritical groups in Section *Eucyperus*. Assessment of Boeckeler's species is difficult since (i) he cited specimens only in very general terms, and (ii) only part of his herbarium (in B) survived the bombing of World War II.

Despite having material available to him in MEL of several new taxa that were subsequently described by others, Mueller described only one new species and one variety in this group (*C. ixiocarpus*, Mueller 1886; *C. umbellatus* var. *fasciculigerus*, Mueller in Tate 1896).

Bentham (1878) made a good synthesis of available literature and specimens in his 'Flora Australiensis' treatment. He described *C. dactylotes*, *C. gilesii*, and *C. gracilis* var.? *rigidella* (p.p. = *C. rigidellus*). In his synoptic key to *Cyperus*, most of the species now included in section *Pinnati* were put in his informal group *Fulvi*, the rest in the informal *Lucidi* with several other species. As with Boeckeler's groupings, Bentham's were of unspecified rank (and indeed not all species were placed in groups) and hence are of no significance nomenclaturally.

Moore and Betche (1893) formally established *C. gunnii* as a variety of *C. lucidus*, a species in sect. *Thunbergiani*. In this they were following Mueller (1874).

C.B. Clarke (1884), in his paper on the *Cyperus* species of India, was the first to consistently use sectional names in *Cyperus* that are nomenclaturally acceptable today. The only species of sect. *Pinnati* mentioned in that paper was *C. sieberi* [= *C. fulvus*], which he placed doubtfully (following Boeckeler) in sect. *Glomerati*. Clarke concentrated on the African and Indian species of Cyperaceae and paid relatively little attention to Australian species, at least in print (the specimens in K are exten-

sively annotated). Two extracts from his massive manuscript monograph of the family were published posthumously. The 'Illustrations' (Clarke 1909) included only *C. fulvus* of sect. *Pinnati* (as *Mariscus fulvus*). In the 'New Genera and Species of Cyperaceae' (Clarke 1908) were described *C. laetus* (= *C. fulvus*), *Mariscus cunninghamii*, *M. rutilans* (= *C. lhotskyanus*) and *M. rigidellus* (based on *C. gracilis* var. ? *rigidella* Benth.). In addition, combinations under *Mariscus* were made for *C. alterniflorus*, *C. gunnii*, *C. fulvus*, *C. angustatus*, *C. holoschoenus* and *C. carinatus*. Clarke placed the species currently put in sect. *Pinnati* in four different sections (with other species) in *Cyperus* sens. strict and *Mariscus*. This was the first time that species of this section had been treated as belonging in the segregate genus *Mariscus*. Unfortunately, being a mere extract from his monograph, the work included no discussion of relationships or morphology.

Domin (1915) also recognised the segregate genus *Mariscus*, describing *Mariscus xerophilus* and *M. aridicola*, and making the combination *M. fasciculigerus* (all three names are synonyms of *C. cunninghamii*). He reduced *C. novae-hollandiae* to varietal rank under *M. gunnii* and described several varieties in the variable species *M. fulvus*. He obligingly provided alternative names under *Cyperus* for his new species – a practice since outlawed by the International Code of Botanical Nomenclature – 'im Sinne der Merzahl der australischer Botaniker, welche die Gattung *Mariscus* nicht anerkennen'. The segregate genus *Mariscus* is still generally not accepted, and not only by Australian botanists.

The period 1916–1931 saw a series of largely uncritical regional Flora treatments. Maiden and Betche (1916) made the combination under *Cyperus* for *Mariscus rutilans*; Fitzgerald (1918) described *C. holoschoenus* var. *viscidus* (= *C. astartodes*); Black (1924) described *C. clelandii* (= *C. dactylotes*) and made the combination under *Cyperus* (1929) for *M. rigidellus*; Gardner (1930) made the combination under *Cyperus* for *M. cunninghamii*.

Kükenthal (1931) described *C. subpinnatus* and its variety *subrigidellus*, both of which are here regarded as belonging to *C. rigidellus*. In his impressive revision (1935–36) of the genus *Cyperus* sens. lat. he set up the section *Pinnati* in subgenus *Mariscus* to include many of the species here placed in this Section. However, a few species here considered as belonging to sect. *Pinnati* were placed by him in sections *Thunbergiani* and *Turgiduli* (with other species). He described no new species but made several new varieties under *C. fulvus*, as well as making combinations in *Cyperus* for Domin's varieties under *Mariscus*. In addition, he reduced *C. sexflorus* and *C. microcephalus* to varietal rank under *C. sporobolus*.

Sectional names used in this paper are those of Kükenthal (1935–36), to enable ready reference to his work, since it is the only recent revision of *Cyperus* sens. lat. The limits of Sections as I currently recognise them often differ somewhat from Kükenthal's; these deviations are mentioned where relevant, e.g. on page 398 et seq. Some of Kükenthal's names should be replaced by earlier sectional names if the current International Code of Botanical Nomenclature is strictly followed. However, this is a part of the Code that I feel should be amended in line with the proposal by Johnson, Briggs & Blaxell (1981). Despite its rejection at the Berlin International Congress, this proposal would save much time currently wasted in searching old and obscure publications for sectional names.

Kükenthal's last contribution to the species under consideration was the description (1940a) of a robust specimen of *C. holoschoenus* from New Guinea as var. *fusci-squamatus*. Blake (1940) elevated *C. betchei* to specific rank, synonymised *C. clelandii* with *C. dactylotes* and *C. ochroleucus* with *C. fulvus*, and described two new species, *C. clarus* and *C. oxycarpus*. Further contributions were on the South Australian species

(Blake 1943), on *C. ixiocarpus* and *C. cunninghamii* (1947a), and on the few New Guinea records (1947b, 1954). As well as providing an amplified description of *C. ixiocarpus*, Blake set up sect. *Ixiocarpi* to accommodate this species. The only nomenclaturally significant point in recent Flora treatments is the selection (without discussion) of *C. angustatus* as the lectotype of sect. *Pinnati* by Kern (1974). Wilson (1980) described *C. portae-tartari* and *C. viscidulus*.

Relationships

Relationships within sect. *Pinnati*

Section *Pinnati* is characterised by a combination of subdigitate or shortly spicate arrangement of spikelets in clusters, the A-type vegetative anatomy (Metcalfe 1971) or modifications thereof, and the variety of dispersal units even within a species (from individual flowers to whole partial inflorescences). In addition, quinone types and the frequency of the aurone mariscetin may be distinctive. It should, however, be remembered that mariscetin has also been found in sect. *Glutinosi* (and sporadically in other Sections) and that A-anatomy is also found in sections *Glutinosi* (= *Viscosi*), *Thunbergiani* and *Turgiduli* (= *Pennati*). The mainly American sect. *Glutinosi* is the group probably most closely related to sect. *Pinnati*; the other two sections are less close. Confirmation (or otherwise) of the monophyly of the Section must wait until other parts of the genus are thoroughly reviewed.

Putative relationships within the Section, based on morphology and vegetative anatomy, are reflected in the species order used in the taxonomic treatment (as far as this is possible in a linear sequence). There are several groups of species that share character states, with a few other species not particularly close to any one group but nevertheless apparently more closely related to species of this Section than to those of other Sections.

Species 1–11 (*C. cunninghamii* to *C. blakeanus*) form one loose group of species in the wet/dry tropics to arid-zone. These are mostly small slender species, shallowly rooted, with leaves mostly not obviously septate-nodulose. They have more or less shining, stramineous to dark brown glumes (rarely dark red-brown and then not as shining as in *C. gunnii* and its allies), with the midrib straight to excurved as seen in side view, and with thick lateral nerves. Unlike most other species of sect. *Pinnati*, nearly all those in this group have the nut falling separately from the glume, notable exceptions being *C. cunninghamii* with its mostly inrolled glumes and *C. crispulus* with its often viscid spikelets. The anthers tend to be short in this group but with a long apical appendage. Species 2–6 (*C. astartodes* to *C. sexflorus*) form a more closely related subgroup, with glumes of similar shape, and red-brown to black (mostly tuberculate) nuts that generally are as long as or exceed the glumes. *C. portae-tartari* (sp. 7) resembles these species (especially *C. microcephalus* subsp. *microcephalus*) in glume shape and general habit, but differs in having a broader nut and often having prickles on the glume midrib. In these latter characters it resembles *C. cracens* and is assigned with that species to a second subgroup that also includes *C. orgadophilus* and *C. sporobolus*, all sharing a similar glume shape and similarly dense, small spikelet clusters. These subgroups are neither exclusive nor necessarily indivisible further: for example, *C. cunninghamii* does not fit in either subgroup described above, because of its often terete and viscid spikelets with very broad rachilla wings and large glume spacing, but it does share other character states with *C. astartodes* and *C. hesperius* in the first subgroup. Similarly, *C. microcephalus*, *C. hesperius* and *C. crispulus* share the unusual character state of a thickened rachilla. *C. orgadophilus*, *C. sexflorus* and *C. sporobolus* have markedly bulbous bases but differ in many other characters.

Species 12, *C. angustatus*, stands out as the only species in the Section with an elongated, slender rhizome. It is a slender perennial of the wet/dry tropics. It is similar to *C. microcephalus* in glume shape and has nuts relatively long compared to the glume (and generally falling separately from the glume), but the soft texture of the rather dull glumes and the pale, smooth nut resemble those of *C. carinatus* and its allies, or to some extent those of *C. perangustus*.

Species 13, 14 (*C. ixiocarpus* and *C. viscidulus*) are perennials of the arid zone to wet/dry tropical region, but they are more robust than spp. 1–11, tend to be deeply rooted, have more or less strongly septate-nodulose leaves, and usually occur in habitats at least seasonally wetter. Their spikelets are usually strongly viscid, so that the nut falls with the glume even though the glume margins are not inrolled. Glumes are stramineous, not very shining (when not viscid), broad, with thick nerves close to the midrib. Nuts are broad-obovate to elliptic and dark red-brown to black in both species, but differ in surface texture.

Species 15–17 (*C. carinatus* to *C. oxycarpus*) are robust wet/dry tropical species and, like species 13 and 14, are found in wetter habitats. They form big shallow-rooted tussocks and tend to have strongly septate-nodulose leaves (*C. oxycarpus* less so). Although septate-nodulose, the leaf bases are relatively smooth and shining. Inflorescences are big and open, with long branches, small spikelet clusters and shortish spikelets. The glumes are pallid to stramineous, often blotched with yellow or red, dull, incurved or straight along the midrib as seen in side view and are of a soft texture compared to, say, *C. gunnii* or *C. cunninghamii*. Nuts are pale yellow-brown to pale red-brown, very narrow-elliptic to narrow-ovate, with a smooth or colliculate surface. The nut of *C. carinatus* is very similar to that of *C. orgadophilus*.

Species 18–20 (*C. betchei*, *C. dactylotes* and *C. fucosus*) are also robust, more or less deeply rooted and septate-nodulose perennials, often with shining leaf bases. They are found in seasonally wet habitats in the tropical to subtropical and arid zones. They differ from spp. 15–17 in their glumes, which are firmer textured and shining, bright yellow to dull red-brown in colour, straight to incurved, with moderately thick nerves. Anthers range from short to long, with a short appendage. Nuts are yellow-brown, narrow-elliptic to narrow-ovate, with a smooth or colliculate surface.

Species 21–24 (*C. gunnii* to *C. centralis*) constitute a group of temperate to arid zone perennials (except for *C. gunnii* subsp. *novae-hollandiae*, which is restricted to the tropical east coast). They are mostly deep-rooted and tall (except *C. lhotskyanus*) with striate, dull leaf bases and septate-nodulose leaves. Their glumes are generally bright or deep red-brown, strongly shining, more or less firm-textured, with fine nerves. Anthers are longish, with a short appendage. The nuts are generally pale, slender, with a smooth or colliculate surface (tuberculate in *C. alterniflorus*).

Species 25 *C. secubans*, a small perennial from the Nandewar Range, has glumes similar to the preceding group, but resembles the following group in vegetative features.

Species 26–31 (*C. isabellinus* to *C. gilesii*) are a group of smallish, subtropical to arid-zone annuals or short-lived perennials of drier habitats. Leaf margins bear erect, blunt prickles or a mixture of types but not regularly antrorsely aculeate prickles. Leaf bases are striate and dull. Glumes have an incurved or straight midrib in outline, and are generally yellow to golden-brown (stramineous with red-brown blotches in *C. rigidellus*), shining, moderately firm-textured, with thick nerves and often with a long and excurved mucro. Rachilla wings are very narrow. Anther appendages are short. Species 26 and 27 (*C. isabellinus* and *C. rigidellus*) form a subgroup characterised by the pale yellowish, narrow-obovate to narrow-elliptic nut, which is generally smooth or colliculate (occasionally tuberculate in *C. rigidellus*). Species 28–30 (*C. clarus* to

C. perangustus) form another subgroup, being similar in gross appearance and glume shape. *C. fulvus* and *C. perangustus* also have in common the spicate clustering of spikelets and the smooth to colliculate nut. *C. clarus* and *C. fulvus* have obovate nuts, *C. perangustus* narrow-obovate. *C. gilesii* shares the general group characteristics but is unique in its long, narrow glumes and very narrow-elliptic nut with red-brown to black, mostly tuberculate, surface.

Species 32, *C. latzii*, is another species that does not fit into any of the subgroups yet still has the general characters of sect. *Pinnati*. It is a smallish short-lived perennial of drier (but still seasonally wet) tropical savanna habitats, characterised by very excurved, variably red-brown to yellow-blotched, glistening glumes with a much-thickened midrib and very thick nerves close to the midrib. Its red-brown nut is of the fairly widespread narrow-elliptic to narrow-obovate shape, and is variably smooth to colliculate or foveate. Its glumes show some resemblance to those of *C. blakeanus*.

Relationships with other Sections in *Cyperus* sens. lat.

Kükenthal (1935–36), in erecting sect. *Pinnati*, in subgenus *Mariscus*, commented: 'Species inter Laxiglumos et Thunbergianos quasi intermediae'. He accordingly put sect. *Pinnati* between sections *Thunbergiani* and *Laxiglumi* in his sequence, and placed in sects. *Thunbergiani* and *Turgiduli* (= *Pennati*) several species that are here included in sect. *Pinnati*. Although sections *Pinnati* and *Thunbergiani* are related, I believe that sect. *Pinnati* is phylogenetically closest to sect. *Glutinosi*, which Kükenthal (erroneously in my opinion) placed distant from these Sections, in his subgenus *Eucyperus*. As long ago as 1874 the intermediate position of such species between *Cyperus* and *Mariscus* was recognised by Mueller: 'C. Holoschoenus a Cyperis genuinis transitum ad eos sectionis Marisci efficit' (1874: 268). The above-mentioned Sections bridge the traditional boundaries of *Cyperus* sens. strict. and *Mariscus*.

Brief notes follow on the various Sections that have been suggested as allies of sect. *Pinnati*, outlining their features and differences from sect. *Pinnati*. Most need more detailed revisionary study. Deviations in delimitation and nomenclature from Kükenthal (1935–36) are indicated.

Sect. *Glutinosi* Boeck. ex Kük. (= sect. *Viscosi* C.B. Clarke on priority). A Section of about six species in North, Central and South America, extending to eastern Pacific and Caribbean islands. I exclude *C. constanzae* Urban and *C. gardneri* Nees from this Section: they have C_3 (non-Kranz) leaf anatomy and are more appropriately placed in sect. *Diffusi*. *C. elegans* L., *C. rubiginosus* Hook. f. (placed by Kükenthal in sect. *Turgiduli*), and *C. trachysanthos* Hook. & Arn. are all very close; they may be better treated as subspecies as done by Eliasson (1965) for *C. rubiginosus*. *C. lacunosus* Griseb. and *C. oxylepis* Nees ex Steud. are more distinctive. *C. oxylepis* is very similar in glume shape to long-glumed specimens of *C. rigidellus* although differing in other details.

The Section was placed in his subgenus *Eucyperus* by Kükenthal but it is very close to sect. *Pinnati* in anatomy and morphology (and flavonoids too probably, although only one species of *Glutinosi* has been analysed (Harborne & Williams pers. comm.)). All species of sect. *Glutinosi* in my restricted sense have A-type anatomy or variants thereof. I sectioned samples of all species; *C. elegans* was also sectioned by Druyts-Voets (1970), who illustrated the culm T.S. (her Figure 5A). Samples of *C. lacunosus*, *C. trachysanthos* and *C. elegans* (Druyts-Voets 1970) showed strict A-anatomy in leaf T.S. However, I found in other samples of *C. elegans* that the anatomy resembled A-anatomy minus the adaxial layer of small vascular bundles. This was also the situation in *C. oxylepis*. In small leaves of *C. rubiginosus*, I found the abaxial layer absent. All these variations correspond to modifications of A-anatomy rather than to B-anatomy since the other characteristics of A-anatomy are still present (adaxial epidermal

cells of similar size to the abaxial cells and the major vascular bundles forming girders).

The similarity of species of sections *Glutinosi* and *Pinnati* was recognised last century (Brown 1810: 215; Mueller 1886: 56). The best summary of the diffences between these two Sections is provided by Blake (1947a) in discussing the affinities of *C. ixiocarpus*:

'The affinities of this attractive and distinctive plant are obscure. Mueller suggested a position near the Tropical American *C. viscosus* Sw. (= *C. elegans* L.), probably on account of the viscid spikelets, but it differs from this species and its immediate allies (sect. *Glutinosi* Boeck.) in that it is the spikelets and not the vegetative parts which are viscid, the foliage is less evidently septate-nodulose, the spikelets are not densely capitate, the glumes are more distant, thinner, not bisulcate and have few nerves, the anthers are not crested, and the style is not thickened at the base...' He continued '...The nearest affinity I can suggest [for *C. ixiocarpus*] is *C. zollingeri* Steud. [= *C. tenuiculmis* Boeck. of section *Subquadrangulares* of subgenus *Eucyperus*].'

Sect. *Subquadrangulares* Kük. (= sect. *Subimbricati* C.B. Clarke by priority). As suggested by Blake (1947a), this Section in subgenus *Eucyperus* of Kükenthal's treatment does show some gross resemblance to *C. ixiocarpus* and to sect. *Laxiglumi* (see below). However, there are many differences. The Section includes twelve species, mostly in Africa but some, such as *C. sphacelatus* Rottb. and *C. tenuiculmis* Boeck., in other tropical regions. Its characteristics are: B-type anatomy (*C. sphacelatus* examined by Metcalfe (1971); four other species examined by me), spikelets in clearly spicate partial inflorescences, dispersal units the individual flowers, glumes generally broad-elliptic and broadly obtuse. Mature spikelets tend to have a characteristic 'thickened' appearance because of the broad nuts.

Sect. *Laxiglumi* (C.B. Clarke) Kük. This Section (= sect. *Pseudomariscus* C.B. Clarke by priority) in subgenus *Mariscus* of Kükenthal's treatment includes about 28 species from North, Central and South America, with one African species (*C. turrillii* Kük.). The other African species that Kükenthal included in it (*C. baoulensis* (Chevalier) Kük.) belongs, in my opinion, in sect. *Subquadrangulares* of subgenus *Eucyperus* (see above). I have not seen material of the Himalayan species *C. sikkimensis* Kük., included in sect. *Laxiglumi* by Kükenthal, but it is phytogeographically unlikely that the species belongs in this Section.

The species of this Section are morphologically similar; Marcks (1974) made a detailed study of the few species of this Section occurring in Wisconsin. The group is characterised by B-type anatomy (13 species sectioned by me), spikelets in spicate or subdigitate partial inflorescences, inflorescences small and often reduced to a few more or less capitate clusters, rachilla not or narrowly winged, glumes often relatively very broad, and dispersal units individual flowers as often as whole spikelets. Generally the species are slender perennials with slender surculi or rhizomes, their culms may be slenderly bulbous-based, and their leaves are not septate-nodulose.

Sect. *Thunbergiani* (C.B. Clarke) Kük. Placed in subgenus *Mariscus* in Kükenthal's treatment. In it, he put 24 species, mainly from subtropical regions, including *C. gunnii*, *C. cunninghamii*, *C. aridicola* and *C. xerophilus* (the latter two with the comment 'Nicht gesehen'). The Section as constituted by Kükenthal is anatomically and morphologically mixed. I would include only the species with A-anatomy in this Section (excluding, of course, those species mentioned above, which belong to sect. *Pinnati*). However, relationships with species in sections *Phleoidei* and *Strigosi* need to be considered before proposing a formal re-organisation.

The species of sect. *Thunbergiani* with A-anatomy (e.g. *C. compactus* Retz., *C. lucidus* R. Br., *C. ustulatus* A. Rich.) differ from those of sect. *Pinnati* in having long-spicate

partial inflorescences, and spikelets with broadly winged rachillas (to 5 mm wide). The dispersal unit is generally the whole spikelet. The plants are mostly very robust, and the leaves are very strongly septate-nodulose, with stout prickles on the margins.

Sect. *Turgiduli* (C.B. Clarke) Kük. (= sect. *Pennati* Kunth on priority). This section in subgenus Mariscus in Kükenthal's treatment includes about eleven species from all parts of the tropics (in Australia: *C. javanicus* Houtt., *C. decompositus* (R. Br.) F. Muell., *C. tetracarpus* Boeck. and *C. conicus* (R. Br.) Boeck.). Kükenthal also included *C. rubiginosus* (which belongs to sect. *Glutinosi*), *C. holoschoenus* (sect. *Pinnati*) and *C. ochroleucus* (= *C. fulvus*). Removing those species, the residual sect. *Turgiduli* includes species with both A-type anatomy (*C. conicus, C. decompositus, C. laeteflorens* (C.B. Clarke) Kük., *C. javanicus* (anatomy illustrated by Govindarajalu 1974) and *C. ligularis* L. (Metcalfe (1971) as *M. rufus*)) and B-type anatomy (*C. andersonii* Boeck., *C. hillebrandii* Boeck., *C. mutisii* (H.B.K.) Griseb. and *C. seemanianus* Boeck.). Despite this, the residual Section seems morphologically fairly homogeneous. It is characterised by 2–3-flowered spikelets in long-spicate partial inflorescences, rachilla often broadly winged, and the dispersal unit always whole spikelets. In these features, it is much closer to what has been called typical *Mariscus* than the above-mentioned Sections.

Formal taxonomy

Cyperus section *Pinnati*

Cyperus section *Pinnati* Kük. (1936: 451); Blake (1940: 42), as 'Pinnatae'. Lectotype (Kern 1974): *C. angustatus* R. Br.

Cyperus section *Glomerati* C.B. Clarke (1884: 142), p.p. min.

Cyperus section *Multiflori* C.B. Clarke (1908: 103), as 'Multiflorae', p.p. min.

Cyperus section *Ixiocarpi* Blake (1947a: 37). Holotype: *C. ixiocarpus* F. Muell.

[*Fulvi* Bentham (1878: 255); under *Cyerus*, no formal status given]

[*Lucidi* Bentham (1878: 256), p.p.; under *Cyperus*, no formal status given]

Erect herbaceous annuals or perennials, tufted or occasionally rhizomatous, occasionally viscid. *Leaves* ± grasslike, often septate-nodulose, with *Mariscus* A-type Kranz anatomy. *Inflorescence* commonly compound; basal inflorescence (involucral) bracts leaf-like, of varying lengths, 1–8 longer than the inflorescence. *Spikelets* arranged in subdigitate or shortly spicate clusters at the apex of ultimate inflorescence branches, with flowers arranged distichously along the often hyaline-winged rachilla; on senescence, spikelet falling as a unit, or rachilla persistent after glumes have fallen individually, or occasionally units of ultimate branch plus spikelets falling. *Stamens* 3. *Style* 3-fid. *Nut* trigonous or occasionally triquetrous.

Thirty-two species, widespread in Australia with a few species extending to New Guinea and introduced in New Zealand and Europe. The conservation status of these species is satisfactory except for the most geographically restricted species, *C. secubans*. This is only known from the Nandewar Range (but within Mt Kaputar National Park), and falls into category 2RC in the classification of Leigh et al. (1984).

The species are outbreeding so far as known; flowers are protogynous. Specimens are often found with half-mature nuts as well as pre-anthetic anthers in the same flower. *C. cunninghamii* subsp. *uniflorus* might be expected to be chasmogamous with its tightly rolled fertile glume completely enclosing the upper part of the spikelet but at least some specimens (e.g. *Hartley 14786, Wilson 4964*) have the stamens and/or stigmas exserted from the apex of the glume. Wind is thought to be the pollinating agent (as in most members of the Cyperaceae).

Keys to species

Practical keys for identifying sedges are notoriously difficult to produce because of the microscopic nature of most of the distinctive characters of these plants. Such keys are generally understood to be useful only in identifying complete, well-grown specimens. In section *Pinnati*, the variation is such that a conventional dichotomous key is both very lengthy and inconclusive for some specimens. For these reasons, a multi-entry key is presented as well. The main advantage of such a key is that one can use whatever characters are available on the specimen, in whatever order one wishes; this is particularly valuable in trying to identify incomplete specimens. Both keys are based on specimens more or less typical for the species, i.e. rare conditions or extreme measurements are generally not covered.

Multi-entry key

Characters are defined and discussed on pp. 363–391. If characters have only two states, only the *less common* state is detailed here (the more common state is given in parentheses). All character states are detailed where there are more than two. The numbers refer to the species (as given in the taxonomic section) and letters to their subspecies. Letters are only listed if the subspecies vary in that character. ***Bold italicised*** species numbers indicate that those species display only one state of that character, species numbers in plain type indicate species showing more than one state of that character. A species number in parentheses indicates that this state is much less common than the other(s) under which this species is listed.

To use this key, choose one character, check the state found in the specimen and then list all the taxa (numbers and letters) in which that state occurs. Repeat for another character, compare that list with the previous list, and delete any numbers not in common. Parentheses should be noted too: if the taxon number is in parentheses (i.e. uncommon) for several characters, then the specimen is less likely to belong to that taxon than to others listed without parentheses. Continue thus until left with a single number (species) or, given the variation within species in this Section, with several numbers. In either case, the specimen should be compared with the relevant description(s) and illustrations to confirm the identification. Immature or stunted specimens may not key out.

The most reliable (least variable) characters are those of the glumes, nuts, rachilla and leaf marginal prickles. It is advisable to start with these characters. If a distinctive character state is present (such as bulbous culm-bases, scabrous glume midrib, or papillate or flabellate leaf marginal prickles) then that will shorten the search.

A listing of species according to the broad regions in which they are known to occur will enable those users who are sure of the geographical provenance of their specimen (or who wish to produce regional keys) to further restrict their search.

1. Annual or short-lived perennial (vs. perennial): 7 ***26*** ***27*** 28 ***31*** 32

2. Shortly but distinctly rhizomatous (vs. tufted, often forming big tussocks by surculi): ***12*** 23

3. Bulbous culm-base (vs. non-bulbous): ***6*** ***9*** ***10*** 11 (24) (29)

4. Viscid spikelets and/or vegetative parts (vs. non-viscid): 1 2 5 8 13 14 22 25 27 29 30

5. Plant height (culm plus inflorescence length)

a. <55 cm: 1 (2) ***3*** 4a***bc*** ***5*** 7 8 9 10 ***11*** 12 13 15 17 18a 19 22 23 24 ***25*** ***26*** ***27*** 28 29 30 ***31*** ***32***

b. 55–100 cm: 1 2 4a ***6*** 7 8 9 10 12 13 14 15 16 17 18ab 19 ***20*** 21 22 23 24 28 (29) 30
c. >100 cm: 14 16 18b 21 22 24

6. Culm diameter (halfway along culm)
a. <1.3 mm: 1ac 3 4a*bc* ***5*** *6 7 8 9 10 11 12 20 23 24* ***25*** 26 27 28 29 30 31 32
b. 1.3–2.4 mm: 1a*bc* 2 3 4ab 6 7 8 9 10 11 12 ***14*** 15 16 ***17*** 18 20 21 22 23 24 26 (27) 28 29 30 31 32
c. >2.4 mm: (1a) 2 4a 7 11 (12) ***13*** 14 15 16 18 ***19*** 20 21 22 23 24 (29)

7. Culms scabrous, at least above (vs. smooth throughout their length): 1 2 4ab 6 7 8 11 12 21 22 24 25 27 28 29 30

8. Leaf shape in cross-section (halfway along lamina)
a. Canaliculate: 1 2 ***3*** 4ab*c* ***5*** 6 ***8*** 9 ***10 11*** 12 ***13*** 14 15 ***16*** 18a 19 20 21 24 ***25*** 27
b. Flattened: 1 2 4ab 6 7 9 12 14 17 18a***b*** 19 21 23 24 ***26*** 28 29 30 31 32
c. Carinate: 7 9 14 15 17 (19) 20 21 ***22*** 23 24 27 28 29 30 31 32

9. Leaf midrib obvious on lower surface (vs. not obvious): 1 2 (3) 4ab 6 7 9 11 14 ***15 17*** 18***a***b 19 20 21 ***22*** 23 24 ***26*** 27 ***28*** 29 ***30 31*** 32

10. Leaves and bracts strongly curly (vs. straight or only slightly curved): 1c 4***bc*** ***5*** 25 ***27*** (28) (29)

11. Leaf width (halfway along lamina)
a. <1.7 mm: 1ac 3 4ab*c* ***5*** 8 9 10 11 12 20 24 ***25*** 27 29 31
b. 1.7–4.5 mm: 1a*bc* 2 3 4ab ***6 7*** 8 9 10 11 12 13 ***14 15*** 16 ***17*** 18 19 20 21***a*** 22 ***23*** 24 ***26*** 27 28 29 ***30*** 31 ***32***
c. >4.5 mm: (1a) 2 4a 7 (9) (10) 13 16 18 19 21***b*** 22 28 29

12. Leaf lamina septate-nodulose (vs. not septate-nodulose): 1 ***2*** 4a ***7*** 8 9 10 11 ***13*** 14 ***15 16 17*** 18 ***19*** 20 ***21 22*** 23 24 26 28 29 ***30*** 31 32

13. Leaf sheaths obviously septate-nodulose (vs. not septate-nodulose): 4a 6 7 15 ***16*** 17 18 ***19*** 20 ***21 22*** 23 24 ***26*** 28 30

14. Leaf sheaths smooth and shining (vs. striate and dull): 1 2 3 ***5 6*** 7 8 11 16 ***17*** 18***b*** 19 ***20*** 21 22 31

15. Leaf sheath colour
a. Stramineous to yellow: 1ab 2 3 4a 7 8 12 13 14 17 19 20 24 26 29 ***30***
b. Pink to pale orange-brown: 1ab*c* 2 3 4a***bc*** 5 7 ***9 10 11*** 15 16 18 (19) 21 ***25 27 28 31*** 32
c. Red-brown to black: 5 ***6*** 8 12 13 14 15 16 17 18 20 21 ***22 23*** 24 26 27 29 32

16. Leaf margins (in uppermost third to quarter of lamina)
(i) Teeth density
a. Dense (<0.05–0.5 mm apart, ± regularly spaced): 1abc 2 ***3 4*** 6 7 9 14 15 18 19 21a***b*** 22 23 24 26 28 29 30 32
b. Sparse (0.6-1.5 mm apart, irregularly or regularly spaced): 1abc 2 5 6 7 ***8*** 9 10 11 ***12*** 13 14 15 16 ***17*** 18 19 20 21a 22 23 24 ***25*** 26 27 28 29 30 ***31*** 32
c. Very sparse (>1.5 mm apart, ± irregularly spaced): 1ac 2 5 10 11 13 16 20 27 29

(ii) Teeth irregularly spaced (vs. regular): 1ac 2 7 9 ***10 11 12 13 15*** 17 18***a*** ***20*** 21 ***23*** 24 ***27 28 29*** 31 ***32***

(iii) Teeth length
a. Very short (<0.05 mm long): 3 4 5 14

b. Short (0.05–0.10 mm long): all species and subspecies.
c. Long (>0.10 mm long): 1 12 18a 21*b* 22 24 26 27 28 29 30

(iv) Teeth shape
a. Aculeate: ***1*** 2 ***4*** 5 ***6*** ***7*** ***8*** ***9*** 10 11 ***12*** ***13*** 14 15 ***16*** ***17*** 18*a*b ***19*** ***20*** ***21*** 22 ***23*** ***24*** ***26*** 28 ***29*** ***30*** 31 32
b. Papillate: 2 ***3*** 5 10 11 14 15 18b (22) ***25*** ***27*** (28) 31 32

(v) Teeth direction (relative to apex)
a. Antrorse: ***1*** 2 3 ***4*** 5 ***6*** ***7*** ***8*** 9 10 11 ***12*** 13 14 15 ***16*** ***17*** 18*a*b ***19*** 20 ***21*** 22 23 ***24*** ***26*** 28 29 ***30*** (32)
b. Erect: 2 3 5 9 11 13 14 15 18b 20 (22) 23 25 ***27*** 28 29 ***31*** 32
c. Retrorse: 2 10 28
d. Flabellate: 10 11 23 25 29 32

17. Inflorescence: order of branching
a. Simple: 1a ***3*** 4*b*c 9 10 11 12 15 17 21a (22) 23 24 ***25*** 26 ***27*** ***28*** 29 ***31*** (32)
b. Small-compound: 1ab 3 4ac 5 8 9 10 11 12 15 17 18a 20 21ab (22) 23 24 26 29 ***30*** 32
c. Compound: 1ab*c* 2 4a 5 ***6*** 7 8 13 14 15 ***16*** 17 18a*b* 19 20 21ab 22 23 32
d. Decompound: 2 4a 5 7 (13) 14 19 20 22

18. Primary inflorescence branches
(i) Number
a. More than 11 (vs. no more than 11): 1ac 2 4a(c) 5 6 ***7*** 13 14 15 18b 19 20 21b (23) 24 26

(ii) Length
a. >10 cm (vs. no more than 10 cm): (1a) 2 3 4a 7 (12) 13 14 15 16 18b 19 20 21 22 23 26

19. Number of leafy inflorescence bracts exceeding inflorescence
a. 0–1: 4b 5 6 8 10 12 14 (15) (16) (18a) 20 (23) 25 (26) 27 (28) (29) 31
b. 2: 1abc 2 (3) 4bc 5 6 8 9 10 11 12 13 14 15 16 (17) 18ab 19 20 21 22 23 24 25 26 27 28 29 30 31 32
c. 3–4: 1abc 2 3 4abc 7 9 10 11 13 14 15 16 17 18ab 19 21 22 (23) 24 26 27 28 29 (30) 31 32
d. 5 or more: (1a) 2 4a 7 9 (11) 17 (19) (29) (30)

20. Spikelet clusters
(i) Shape
a. Ovoid: 1*b* 9 10 11 30
b. Globose: 1*a*c 7 8 14 16 17 19 21a 22 23 ***25*** 26 27 ***28*** 29 30 31 32
c. Hemispherical (more or less so – often with very few spikelets): 1c ***2*** ***3*** ***4*** ***5*** ***6*** 7 8 9 10 11 ***12*** ***13*** 14 ***15*** 16 17 ***18*** 19 ***20*** 21a*b* 22 23 ***24*** 26 27 29 30 31 32

(ii) Spikelets arranged spicately in the clusters (vs. subdigitately arranged): 1a 6 11 18b 21b 22 24 ***29*** ***30***

(iii) Diameter
a. <1.2 cm: 1ab*c* 2 4a(b)*c* 5 6 7 ***8*** 9 10 11 (12) 14 15 ***16*** 17 (19) (20) 21a(b) (22) (23) 24 25 (26) (27) 32
b. 1.2–2.5 cm: 1ab 2 3 4ab 5 6 (7) 9 10 11 12 13 14 15 17 18(a)b 19 20 21ab 22 23 24 25 26 27 28 29 30 31 32
c. >2.5 cm: 2 3 4b 6 12 13 18ab 19 20 21(a)b 22 (23) 26 27 28 29 30 31

21. Spikelet
(i) Shape in cross-section
a. Terete (vs. laterally compressed): 1a*c*

(ii) Length
a. <6 mm: 1a*c* 4ac 5 6 7 8 9 10 11 14 15 ***16*** 17 (18a) 19 22 24 27 30 32
b. 6–20 mm: 1a***b*** **2** 3 4abc 5 6 7 (8) (9) (10) (11) 12 13 14 15 17 18ab 19 20 21 22 23 24 ***25*** 26 27 ***28*** 29 30 31 32
c. >20 mm: 3 4b 12 13 18ab (19) (20) (21) (22) (23) 26 (27) (29) 31

(iii) Width (from glume apex to glume apex)
a. <1.2 mm: 1a*c* 4a 5 21b
b. 1.2–2.5 mm: 1ab ***2*** ***3*** 4ab*c* ***5*** ***6*** ***7*** 8 9 ***10*** 11 ***12*** ***14*** 15 16 (17) 18***a***b ***19*** ***20*** 21***a***b 22 (23) 24 (25) ***26*** (27) 29 ***30*** (31) 32
c. >2.5 mm: 1b 4b 8 9 11 ***13*** 15 16 17 18b 22 23 24 25 27 ***28*** 29 31 32

(iv) Number of fertile flowers per spikelet
a. <6: 1ab*c* 2 (3) 4abc 5 6 ***7*** ***8*** ***9*** 10 11 (14) (15) 16 17 (21b) 24 25 30
b. 6–20: 1ab 2 3 4abc 5 6 7 9 10 11 12 13 14 15 16 17 18 19 20 21ab 22 23 24 25 26 27 ***28*** 29 30 31 ***32***
c. >20: (2) 3 4ab 12 13 14 (15) 18 (19) (20) 21ab (22) (23) (26) (27) (29) (30) 31

22. Rachilla
(i) Wing broad, i.e. 0.1–0.25 mm wide (vs. absent or narrow): ***1*** 4ac 5 (6) ***7*** ***8*** ***9*** 10 11 ***12*** 13 18***a***b 21a 22 23 26 27 28 29 30 31
(ii) Thick in side view, i.e. at least 1.0 mm thick (vs. thin): ***3*** 4a***bc*** 5 (6) 9 (11) 14 (15) (32)
(iii) Glume spacing (i.e. distance between adjacent glume bases on same face of rachilla)
a. <1.4 mm: (2) 4 5 6 7 (8) 10 11 12 14 ***15*** ***16*** ***17*** 18b ***19*** ***20*** 21a 22 23 (24) 25 27 28 29 31 32
b. 1.4–2.1 mm: (1a) 2 ***3*** 4 5 6 (7) 8 ***9*** 10 (11) 12 (14) 18ab 21a***b*** 22 23 24 25 ***26*** 27 28 29 ***30*** 31 (32)
c. >2.1 mm: 1a***b*** ***13*** 18a 21a 24 27

23. Glume
(i) Length of mucro
a. <0.25 mm: 1a***bc*** ***2*** 3 4***a***bc ***5*** ***6*** 7 8 9 ***10*** ***11*** ***12*** 13 ***14*** ***15*** ***16*** ***17*** 18***a***b ***19*** ***20*** ***21*** 22 23 24 ***25*** 26 27 29 ***30*** ***32***
b. 0.25—0.45 mm: 1a 3 4bc 7 8 9 13 18b 22 23 24 26 27 28 29 31
c. >0.45 mm: (7) 8 9 13 18 23 (26) 28 (29) 31
(ii) Shape of mucro
a. Excurved: 1a 4b 7 ***8*** 9 18a 20 22 23 27 28 ***31***
b. Straight: 1a***bc*** ***2*** ***3*** 4***a***bc ***5*** ***6*** 7 9 10 ***11*** ***12*** ***13*** ***14*** ***15*** ***16*** ***17*** 18a***b*** ***19*** 20 ***21*** (22) 23 ***24*** ***25*** ***26*** 27 (28) ***29*** ***30*** ***32***
c. Incurved: 9 10
(iii) Overall length of glume (including mucro)
a. <2.2 mm: 4***a***bc ***5*** ***6*** ***7*** 8 9 10 11 12 14 15 ***16*** (18b) 19 20 21ab (22) 27 29 30 32
b. 2.2–3.0 mm: 1 ***2*** ***3*** 4b 8 9 10 11 12 ***13*** (14) 15 ***17*** 18ab 19 20 21ab 22 23 24 ***25*** (26) 27 28 29 (30) (31) 32
c. >3.0 mm: 1 4b 18ab 21a 22 23 24 26 27 28 31
(iv) Width of glume in side view (i.e. from midrib to lateral margin)
a. <0.7 mm wide: 1a***c*** ***2*** ***3*** 4***a***bc ***5*** 6 7 9 10 11 ***12*** 13 14 15 ***16*** 17 18 19 ***20*** 21a***b*** 24 28 29 30 31 32
b. 0.7–0.9 mm wide: 1a***b*** (4b) 6 7 8 9 10 11 13 14 15 17 18 19 21a 22 23 24 25 ***26*** 27 28 29 30 31 32
c. >0.9 mm wide: 1a 8 9 11 22 23 24 25 27 28 (29) 32
(v) Shape of glume (as seen if flattened out)
a. Obovate to elliptic (i.e. broadest in uppermost third to half): ***1*** ***2*** 3 4ac ***5*** 6 7 8 ***10*** 11

12 13 14 15 16 18 19 20 ***21*** ***22*** 23 24 25 26 27 28 ***29*** ***30*** 31 32
b. Ovate (i.e. broadest in lowermost third): 3 4a***bc*** 6 7 8 ***9*** 11 12 13 14 15 16 ***17*** 18 19 20 23 24 25 26 27 28 31 32

(vi) Midrib scabrous (vs. smooth): (1) 7 (8) 16

(vii) Glume margins inrolled and clasping nut (vs. not inrolled and thereby not clasping nut, unless viscid): 1***ac*** 2 3 5 ***15*** 17 18a***b*** 19 20 21 22 23 ***24*** 25 ***26*** 27 28 ***29*** 30 ***31***

(viii) Colour of glume
a. Stramineous to dark golden-brown: ***1*** 2 3 4 5 6 8 9 10 11 12 ***13*** ***14*** ***15*** 16 ***17*** 18 19 (20) 21(a)b 22 24 ***26*** ***28*** 29 ***30*** 31 32
b. Stramineous to golden with red-brown blotches: 6 27 29
c. Red-brown to dark red-brown: 2 3 4 5 6 *7* 8 9 10 11 12 16 (18) (19) 20 21ab 22 ***23*** 24 ***25*** 27 31 32

24. Anther

(i) Length (excluding appendage)
a. <1.2 mm: 1abc 2 ***3*** ***4*** ***5*** ***6*** ***7*** ***8*** ***9*** ***10*** ***12*** 13 ***14*** ***15*** ***16*** 17 18 ***19*** ***20*** 21 22 26 27 ***28*** 29 ***30*** ***31*** ***32***
b. 1.2–1.5 mm: 1abc (2) 11 13 (17) 18 21 22 23 24 25 26 (27) (29)
c. >1.5 mm: 1b 11 22 23 24 25

(ii) Length of apical appendage
a. <0.15 mm: 1a 2 (4c) (5) 8 10 11 ***12*** ***13*** 14 ***15*** 16 ***17*** ***18*** ***19*** ***20*** ***21*** ***22*** ***23*** 24 ***25*** ***26*** ***27*** ***28*** ***29*** ***30*** ***31***
b. 0.15–0.35 mm: 1a***bc*** 2 3 4abc 5 6 *7* 8 ***9*** 10 11 ***14*** 16 (24) 32
c. >0.35 mm: 1c 3 4abc 6 8 32

25. Nut

(i) Length
a. <1.6 mm: (2) 3 4 5 *7* 8 10 11 (12) 14 16 19 20 21a 27 29 ***30*** 32
b. 1.6–2.3 mm: 1a***bc*** 2 3 4 5 ***6*** 8 ***9*** 10 11 12 ***13*** 14 ***15*** 16 ***17*** 18***ab*** 19 20 21a***b*** ***22*** 23 ***24*** ***25*** 26 27 ***28*** 29 31 32
c. >2.3 mm: 1ab 18b (23) 26 27 31

(ii) Diameter
a. <0.6 mm: 1a***c*** ***2*** ***3*** 4a***bc*** ***5*** 6 7 9 10 11 12 15 16 ***17*** ***18*** ***19*** ***20*** 21a***b*** 22 24 27 30 ***31*** 32
b. 0.6–0.8 mm: 1a***b*** 4a 6 7 8 9 10 11 12 ***14*** 15 (16) 21a 22 ***23*** 24 ***25*** ***26*** 27 ***28*** 29 (30) (32)
c. >0.8 mm: 8 9 ***13*** (29)

(iii) Shape (in outline)
a. Obovate: 4a 5 6 *7* ***8*** 9 10 ***11*** 12 13 14 15 18b 19 22 23 25 26 27 29 ***30*** 32
b. Elliptic or linear: 1 2 3 4a***bc*** 5 6 9 10 12 13 14 15 ***16*** 17 18***ab*** 19 ***20*** ***21*** 22 23 ***24*** 25 26 27 ***28*** 29 ***31*** 32
c. Ovate: 1 2 3 4a 17

(iv) Faces
a. Concave: 4a 6 *7* ***8*** 9 11 ***13*** 14 16 17 27 28
b. Flat: 1ab***c*** ***2*** ***3*** 4a***bc*** 6 7 9 ***10*** 11 ***12*** 14 15 16 17 ***18*** ***19*** ***20*** 21 ***22*** ***23*** 24 ***25*** 26 27 28 29 30 ***31*** ***32***
c. Convex: 1ab ***5*** 15 21 24 26 27 29 30

(v) Surface texture
a. Tuberculate (i.e. with small widely spaced elevations): 1a***bc*** 2 3 4***ac*** 5 6 *7* ***8*** 9 10 13 20 ***22*** 27 ***28*** 31
b. Colliculate (with broad, rounded elevations completely covering the surface): 3 4b 5 6 10 13 14 15 16 18ab 19 21 23 24 25 26 27 29 30 32
c. Smooth and reticulate-areolate: 1a 2 4bc ***11*** ***12*** 14 15 16 ***17*** 18(a)b 19 20 21 23 24 25 26 (29) 30 31 32
d. Foveate (pitted): 1a 4b 14 19 20 24 26 30 31 32

(vi) Surface more or less evenly shining (vs. glistening or dull): 4*abc* ***5*** ***8*** 9 ***10*** ***11*** ***12*** ***13*** ***14*** ***15*** ***16*** ***17*** ***18*** ***21*** ***23*** 24 25 26 ***29*** 30 32

(vii) Colour

a. Pale yellow-brown to dark golden-brown: 10 11 12 15 16 17 ***18*** ***19*** ***20*** 21 23 24 25 ***26*** ***27*** ***29***

b. Pale to dark red-brown: 1 **2** 3 4 5 6 9 10 11 12 13 14 15 16 21 ***22*** 24 25 ***30*** 31 ***32***

c. Grey to black: 1 3 4 5 (6) ***7*** ***8*** 9 13 14 ***28*** 31

(viii) Nut falling separately from glume (vs. falling clasped by glume): 1b 3 ***4*** ***5*** ***6*** ***7*** ***8*** ***9*** ***10*** ***11*** ***12*** ***16*** (23) 27 28 30 ***32***

26. Regions of occurrence

a. Queensland: 1ab 4ac 6 7 10 11 12 13 15 16 17 18 19 20 21a*b* 22 ***26*** 27 28 29 ***30*** 31

b. New South Wales: 18a 19 21a 22 23 ***25*** 27 28 29 31

c. Victoria: 21a 23 27

d. Tasmania: 21a

e. South Australia: 19 21a 22 23 24 27 31

f. Northern Territory: 1 2 4 5 6 7 8 ***9*** 10 11 12 13 14 15 16 17 18b 20 24 27 31 32

g. Western Australia: 1 2 ***3*** 4 5 6 8 10 11 13 14 15 16 17 18b 22 24 27 32

h. New Guinea: 12 16 29

i. New Zealand: 21a

Bracketed dichotomous key

The number in brackets after certain leads (e.g. after lead 5) refers back to the previous lead in that path.

1 Culm bases bulbous **2**
1 Culm bases not bulbous (or rarely somewhat bulbous, in young plants) **6**

2 Anthers 0.4–1.0 mm long **3**
2 Anthers 1.2–2.3 mm long **5**

3 Inflorescence compound; spikelets few in loose clusters ..... **6. C. sexflorus**
3 Inflorescence simple or small-compound; spikelets numerous in dense clusters **4**

4 Rachilla thickened, broadly winged, wings 0.1–0.2 mm wide; glume spacing 1.5–2.1 mm; glumes broad-ovate with mucro 0.2–0.5 mm long; nut very dark red-brown to black ..... **9. C. sporobolus**
4 Rachilla not thickened, usually narrowly winged, wings to 0.1 mm wide; glume spacing 0.7–1.5 mm; glumes elliptic with mucro <0.1–0.2 mm long; nut pale yellow-brown to pale red-brown ..... **10. C. orgadophilus**

5 Nut obovate; glume margins not inrolled ..... **11. C. blakeanus**
5 Nut very narrow-elliptic; glume margins inrolled and clasping the nut ..... **24. C. centralis**

6 (1) Spikelets with 1 fertile flower, more or less terete ..... **1. C. cunninghamii**
6 Spikelets with 2–50 fertile flowers, more or less laterally compressed **7**

7 Glumes < 2.2 mm long **8**
7 Glumes ≥ 2.2 mm long **39**

8 Inflorescence simple or small-compound **9**
9 Inflorescence compound to decompound **25**
9 Plant with long slender rhizome ..... **12. C. angustatus**
9 Plants tufted or forming tussocks by short surculi **10**

10 Leaves and bracts strongly curly **11**
10 Leaves and bracts straight or slightly curved **15**

11 Rachilla thickened in cross-section **12**
11 Rachilla not thickened in cross-section **13**

12 Leaf marginal prickles dense, antrorsely aculeate ..... **4. C. microcephalus**
12 Leaf marginal prickles sparse to very sparse, mixed: antrorse to erect, aculeate to papillate ..... **5. C. crispulus**

13 Mature nut very dark red-brown to black ..... **5. C. crispulus**
13 Mature nut pale brown **14**

14 Spikelets in subdigitate clusters; leaf sheaths pinkish to purplish red ..... **27. C. rigidellus**
14 Spikelets in shortly spicate clusters; leaf sheaths yellowish with red-brown blotches ..... **29. C. fulvus**

15 (10) Rachilla thickened in cross-section ..... **4. C. microcephalus**
15 Rachilla not thickened in cross-section **16**

16 Glume margins more or less strongly inrolled and clasping nut so that nut and glume fall together **17**
16 Glume margins not or only slightly inrolled so that nut and glume usually fall separately **22**

17 Nut surface tuberculate or foveate **18**
17 Nut surface colliculate or smooth and reticulate-areolate **19**

18 Anthers 0.3–0.7 mm long; leaf marginal prickles short and very sparsely and irregularly spaced ..... **20. C. fucosus**
18 Anthers 1.1–1.8 mm long; leaf marginal prickles long and usually densely and regularly spaced ..... **22. C. alterniflorus**

19 Leaf sheaths pinkish to dark red-purple; glume spacing 0.7–1.2 mm ..... **15. C. carinatus**
19 Leaf sheaths stramineous (with or without red-brown blotches) to orange- or grey-brown; glume spacing 1.2–2.2 mm **20**

20 Nut very narrow-elliptic to narrow-elliptic ..... **21. C. gunnii**
20 Nut obovate to narrow-obovate or broad-elliptic **21**

21 Nut 1.5–2.0 mm long, 0.6–0.9 mm diam.; leaf marginal prickles irregularly spaced, mixed flabellate to erect or antrorsely aculeate; spikelets 2–3.5 mm wide in side view; glumes 0.6–1 mm wide in side view ..... **29. C. fulvus**

21 Nut 1.3–1.5 mm long, 0.5–0.6 mm diam.; leaf marginal prickles regularly spaced, strongly antrorsely aculeate; spikelets 1.5–2 mm wide in side view; glumes 0.5–0.7 mm wide in side view ..... **30. C. perangustus**

22 (16) Anthers 1.2–2.0 mm long ..... **11. C. blakeanus**
22 Anthers 0.3–1.1 mm long **23**

23 Glumes broad-elliptic to broad-ovate, with mucro 0.2–0.6 mm long; nut broad-obovate to obovate, black, 0.7–1.3 mm diam. ..... **8. C. cracens**
23 Glumes narrow-ovate to elliptic, with mucro 0.1–0.2 mm long; nut narrow-obovate to narrow-elliptic, red-brown, 0.4–0.6 mm diam. **24**

24 Culms scabrous; spikelet clusters spicate; leaf marginal prickles long antrorsely aculeate ..... **30. C. perangustus**
24 Culms smooth; spikelet clusters subdigitate; leaf marginal prickles short, mixed ..... **32. C. latzii**

25 (8) Leaves and bracts strongly curly ..... **5. C. crispulus**
25 Leaves and bracts straight or only slightly curved **26**

26 Anthers < 1.2 mm long **27**
26 Anthers 1.2–1.8 mm long **37**

27 Mucro excurved (occasionally ± straight in *C. portae-tartari*), 0.2–0.6 mm long; glumes occasionally with antrorse prickles on midrib **28**
27 Mucro straight, ≤ 0.2 mm long; glumes smooth (rarely minutely scabrous in *C. holoschoenus*) **29**

28 Inflorescence narrow, slender, with 1–2 long involucral bracts; glumes 0.8–1.1 mm wide in side view; leaves canaliculate in cross-section, midrib not obvious ..... **8. C. cracens**
28 Inflorescence about as broad as long, with 3–8 long bracts; glumes 0.5–0.7 mm wide in side view; leaves V-shaped, midrib obvious abaxially and scabrous ..... **7. C. portae-tartari**

29 Nut tuberculate ..... **4. C. microcephalus**
29 Nut smooth and reticulate-areolate or colliculate or foveate **30**

30 Nut falling with glume **31**
30 Nut falling separately from glume **32**

31 Mature spikelets viscid; nut dark red-brown to black ..... **14. C. viscidulus**
31 Mature spikelets not viscid; nut yellow-brown to pale red-brown **32**

32 Glumes stramineous or yellowish with broad white-membranous margins ..... **15. C. carinatus**
32 Glumes yellow or red with margins of a similar colour and texture or narrow-hyaline **33**

33 Glume spacing 0.9–1.3 mm; anthers 0.3–0.7 mm long **34**
33 Glume spacing 1.3–2.2 mm; anthers 0.7–1.5 mm long **35**

34 Glumes bright yellow to dark golden-brown (rarely red-brown), 1.3–2.1 mm long, with acute apex; involucral bracts (2–)3–5; leaf margins with prickles regularly spaced ..... **19. C. dactylotes**
34 Glumes dull red-brown or occasionally stramineous, 1.8–2.8 mm long, with apex retuse to broad-acute; involucral bracts 1–2; leaf margins with prickles irregularly spaced ..... **20. C. fucosus**

35 Leaf marginal prickles antrorsely aculeate; leaf sheaths striate but shining ..... **21. C. gunnii**
35 Leaf marginal prickles mixed antrorse to erect, aculeate to papillate; leaf sheaths smooth and shining ..... **18. C. betchei**

36 (30) Glume spacing 0.5–0.9 mm; spikelets 2–5 mm long, 2–6-flowered; leaf marginal prickles antrorsely aculeate ..... **16. C. holoschoenus**
36 Glume spacing 1.0–1.5 mm; spikelets 5–17 mm long, 6–20-flowered; leaf marginal prickles erect to flabellate, aculeate to papillate ..... **32. C. latzii**

37 (26) Nut tuberculate, red-brown ..... **22. C. alterniflorus**
37 Nut smooth to colliculate, yellow-brown **38**

38 Leaf marginal prickles antrorsely aculeate; leaf sheaths striate but shining ..... **21. C. gunnii**
38 Leaf marginal prickles mixed antrorse to erect, aculeate to papillate; leaf sheaths smooth and shining ..... **18. C. betchei**

39 (7) Inflorescence simple or small-compound **40**
39 Inflorescence compound to decompound **77**

40 Plants with long, slender rhizome **41**
40 Plants tufted or forming tussocks by surculi **42**

41 Glumes 1.6–2.3 mm long, c. 0.5 mm wide in side view ..... **12. C. angustatus**
41 Glumes 2.6–4.0 mm long, 0.8–1.0 mm wide in side view ... **23. C. lhotskyanus**

42 Leaves and bracts strongly curly **43**
42 Leaves and bracts straight or slightly curved **48**

43 Rachilla thickened ..... **4. C. microcephalus**
43 Rachilla not thickened **44**

44 Glumes dark red-brown **45**
44 Glumes stramineous to golden brown, sometimes with red-brown blotches **46**

45 Anthers 1.3–1.6 mm long; glume mucro ≤ 0.1 mm long; leaf marginal prickles mixed erect to flabellate, papillate or aculeate, regularly spaced **25. C. secubans**
45 Anthers 0.3–1.2 mm long; glume mucro 0.1–0.4 mm long; leaf marginal prickles erect, papillate, irregularly spaced ..... **27. C. rigidellus**

46 Glumes evenly yellow to golden brown, with mucro 0.3–0.8 mm long (usually excurved); nut [tuberculate,] grey to black ..... **28. C. clarus**
46 Glumes stramineous to golden brown and with dull red-brown blotches, with straight mucro 0.1–0.3 mm long; nut pale yellow-brown **47**

47 Leaf marginal prickles erect, papillate; spikelets arranged subdigitately in clusters; nut tuberculate or small-colliculate ..... **27. C. rigidellus**
47 Leaf marginal prickles either mixed strongly flabellate to erect aculeate *or* antrorsely aculeate; spikelets arranged spicately in clusters; nut colliculate to smooth and reticulate-areolate ..... **29. C. fulvus**

48 (42) Rachilla thickened as seen in side view ..... **3. C. hesperius**
48 Rachilla thin **49**

49 Glume margins more or less strongly inrolled and clasping nut so that nut and glume fall together **50**
49 Glume margins not or only slightly inrolled; nut and glume usually falling separately **62**

50 Nut red-brown to black, tuberculate (occasionally smooth in *C. cunninghamii* and *C. gilesii*) **51**
50 Nut yellow-brown to dark golden-brown (occasionally pale red-brown in *C. gunnii* and *C. centralis*), smooth to colliculate or foveate **54**

51 Glume spacing 2.0–4.7 mm ..... **1. C. cunninghamii**
51 Glume spacing 1.0–1.9 mm **52**

52 Anthers 1.1–1.8 mm long [nut red-brown, narrow-elliptic to narrow-obovate] ..... **22. C. alterniflorus**
52 Anthers 0.3–0.8 mm long **53**

53 Nut very narrow-elliptic, red-brown to blackish; glumes very narrow-elliptic to narrow-ovate ..... **31. C. gilesii**
53 Nut obovate, grey to black; glumes elliptic to ovate ..... **28. C. clarus**

54 (50) Leaf margins antrorsely aculeate, more or less regularly spaced **55**
54 Leaf margins mixed aculeate to papillate, antrorse to erect and flabellate, more or less irregularly spaced **58**

55 Spikelet clusters dense; leaves exceeding or as long as culms; culms 2–4 mm diam. ..... **21. C. gunnii**
55 Spikelet clusters loose; leaves shorter than to as long as culms; culms 1–2.7 mm diam. 56

56 Anthers 1.3–2.3 mm long; rachilla not or very narrowly winged **24. C. centralis**
56 Anthers 0.7–1.4 mm long; rachilla narrowly to broadly winged 57

57 Tussock-forming perennial ..... **18. C. betchei**
57 Tufted annual or short-lived perennial ..... **26. C. isabellinus**

58 (54) Anthers 0.3–1.2 mm long 59
58 Anthers 1.3–2.0 mm long 61

59 Nut obovate to elliptic, 0.6–1 mm diam.; glume spacing 1.2–2.0 mm **29. C. fulvus**
59 Nut very narrow-elliptic to narrow-obovate, 0.4–0.7 mm diam.; glume spacing 0.7–1.3 mm 60

60 Leaf midrib obvious abaxially; glumes stramineous to yellow with broad white membranous margins; spikelet clusters dense ..... **15. C. carinatus**
60 Leaf midrib not obvious; glumes dull red-brown or pallid with narrow hyaline margins; spikelet clusters loose ..... **20. C. fucosus**

61 (58) Leaves V-shaped in cross-section, with midrib obvious abaxially, marginal prickles mixed antrorse to erect and flabellate, aculeate, irregularly spaced; plants not viscid ..... **23. C. lhotskyanus**
61 Leaves canaliculate, with midrib not obvious, marginal prickles erect to flabellate, papillate, regularly spaced; plants often viscid ..... **25. C. secubans**

62 (49) Anthers less than 1.2 mm long 63
62 Anthers 1.2–2.0 mm long (rarely anthers 1.1 mm long in *C. cunninghamii* subsp. *cheradicus* and *C. alterniflorus*) 71

63 Leaf marginal prickles regularly antrorsely aculeate 64
63 Leaf marginal prickles mixed, irregularly or regularly spaced 68

64 Nut 0.8–1.3 mm diam., obovate to broad-obovate, tuberculate, black **8. C. cracens**
64 Nut 0.3–0.7 mm diam., very narrow-elliptic to narrow-ovate, colliculate to smooth, yellow-brown to dark golden-brown (occasionally pale red-brown) 65

65 Glume spacing 0.7–1.2 mm; spikelets 2.5–3.5 mm wide in side view; glumes stramineous, long-acute and densely arranged to give a striking chevron effect ..... **17. C. oxycarpus**
65 Glume spacing 1.2–2.3 mm (if <1.5 mm, then glumes dark red-brown); spikelets 1–2.5 m wide in side view; glumes broad-acute to obtuse 66

66 Spikelet clusters dense, with numerous spikelets; leaves longer than to as long as culms; glumes dark red-brown or stramineous ..... **21. C. gunnii**
66 Spikelet clusters loose, with no more than 10 spikelets; leaves shorter than to as long as culms; glumes yellowish to dark golden-brown 67

67 Culms smooth; glume spacing 1.6–2.3 mm; rachilla wings 0.1–0.25 mm wide; anthers 0.8–1.4 mm long; nut 1.9–2.2 mm long ..... **18. C. betchei**
67 Culms scabrous; glume spacing 1.4–1.7 mm; rachilla wings 0.05–0.1 mm wide; anthers 0.3–0.7 mm long; nut 1.3–1.5 mm long ..... **30. C. perangustus**

68 (63) Nut obovate, grey to black, 0.6–0.8 mm diam.; glume mucro 0.3–0.8 mm long, more or less excurved ..... **28. C. clarus**
68 Nut very narrow-elliptic to narrow-ovate, yellow-brown to dark red-brown (occasionally black in *C. hesperius*); glume mucro ≤ 0.3 mm long, mostly straight 69

69 Tall but slender perennial, 65–90 cm high; anther appendage ≤ 0.1 mm long ..... **20. C. fucosus**
69 Short perennial, 30–50 cm high; anther appendage 0.2–0.5 mm long **70**

70 Glume spacing 1.5–1.8 mm; rachilla thick in side view; inflorescence clusters 2–5 cm diam.; spikelets c. 2 mm wide in side view ..... **3. C. hesperius**
70 Glume spacing 1.0–1.5 mm; rachilla thin; inflorescence clusters 1-2 cm diam.; spikelets 2–4 mm wide in side view ..... **32. C. latzii**

71 (62) Nut tuberculate **72**
71 Nut smooth to colliculate **73**

72 Glume spacing 2.2–3.5 mm ..... **1. C. cunninghamii**
72 Glume spacing 1.0–1.9 mm ..... **22. C. alterniflorus**

73 Leaf marginal prickles more or less regularly antrorsely aculeate **74**
73 Leaf marginal prickles mixed aculeate to papillate, antrorse to erect and flabellate, irregularly or regularly spaced **75**

74 Spikelet clusters dense; leaves longer than to as long as culms; glumes dark red-brown or stramineous ..... **21. C. gunnii**
74 Spikelet clusters loose; leaves shorter than to as long as culms; glumes yellowish to dark golden-brown ..... **18. C. betchei**

75 Leaves V-shaped in cross-section, leaf bases dark purplish red ..... **23. C. lhotskyanus**
75 Leaves canaliculate in cross-section; leaf bases pale brown, occasionally with red-brown blotches **76**

76 Leaf marginal prickles irregularly spaced, aculeate to papillate, antrorse to erect; glumes yellowish with red-brown blotches or evenly red-brown, narrow-ovate with long-acute apex; spikelets mostly 3–5 mm long ..... **11. C. blakeanus**
76 Leaf marginal prickles regularly spaced, papillate, erect to flabellate; glumes dark red-brown, obovate to elliptic with retuse to broad-acute apex; spikelets 7–9 mm long ..... **25. C. secubans**

77 (39) Nut broad-obovate to obovate (occasionally narrow-elliptic in *C. ixiocarpus*), black, 0.8–1.3 mm diam **78**
77 Nut very narrow-elliptic to narrow-obovate, yellow-brown to red-brown (occasionally black in *C. cunninghamii* but then very narrow-elliptic to narrow-ovate), 0.3–0.7 mm diam. (rarely to 1 mm diam. in *C. lhotskyanus*) **79**

78 Glume spacing 1.3–1.8 mm ..... **8. C. cracens**
78 Glume spacing 2.2–2.7 mm ..... **13. C. ixiocarpus**

79 Leaf marginal prickles regularly antrorsely aculeate **80**
79 Leaf marginal prickles more or less irregularly mixed **84**

80 Nut pale red-brown to black, tuberculate or occasionally smooth or foveate **81**
80 Nut pale yellow-brown to dark golden-brown, colliculate or smooth **82**

81 Glume spacing 2.0–4.7 mm; glumes stramineous to golden-brown ..... **1. C. cunninghamii**
81 Glume spacing 1.0–1.9 mm; glumes red-brown to golden-brown ..... **22. C. alterniflorus**

82 Glume spacing 0.7–1.2 mm; glumes stramineous, long-acute and densely arranged to give a striking chevron effect ..... **17. C. oxycarpus**
82 Glume spacing 1.2–2.3 mm (if <1.5 mm, then glumes dark red-brown); glumes broad-acute to obtuse **83**

83 Spikelet clusters dense; leaves longer than to as long as culms; glumes dark red-brown or stramineous ..... **21. C. gunnii**
83 Spikelet clusters loose; leaves shorter than to as long as culms; glumes yellowish to dark golden-brown ..... **18. C. betchei**

84 (79) Nut pale to dark red-brown **85**
84 Nut pale yellow-brown to dark golden-brown **86**

85 Tall perennial 50–100 cm high, culms 2–5 mm diam., leaves 3.5–11 mm wide; glume spacing 1.3–2.1 mm; nut falling with glume ..... **2. C. astartodes**
85 Short annual or perennial 30–50 cm high, culms 1–2 mm diam., leaves 2–4 mm wide; glume spacing 1.0–1.5 mm; nut not falling with glume ..... **32. C. latzii**

86 Anthers 1.3–1.7 mm long; slender perennial with long surculi, forming small tufts ..... **23. C. lhotskyanus**
86 Anthers 0.4–1.3 mm long; robust perennials forming large tussocks **87**

87 Glumes with broad white-membranous margins ..... **15. C. carinatus**
87 Glumes with margins of similar texture to rest of glume or narrow-hyaline **88**

88 Glume spacing 1.3–2.0 mm; anthers 0.7–1.3 mm long; leaf midrib usually obvious abaxially ..... **18. C. betchei**
88 Glume spacing 0.9–1.3 mm; anthers 0.3–0.7 mm long; leaf midrib usually not obvious **89**

89 Glumes bright yellow to dark golden-brown (rarely red-brown), 1.3–2.1 mm long, with acute apex; involucral bracts (2–)3–5; leaf margins with prickles regularly spaced ..... **19. C. dactylotes**
89 Glumes dull red-brown or occasionally stramineous, 1.8–2.8 mm long, with apex retuse to broad-acute; involucral bracts 1–2; leaf margins with prickles irregularly spaced ..... **20. C. fucosus**

Description of species

1. Cyperus cunninghamii *(C.B. Clarke) C. Gardner*
Gardner (1930: 12)

More or less slender perennial, tufted, 30–70(-100) cm high, often viscid towards base of plant and spikelets. *Culms* trigonous to terete, smooth or scabrous, 1–2(–3.5) mm diam. *Leaves* occasionally thickened, canaliculate or occasionally flat in big specimens, septate-nodulose in big specimens, shorter than to exceeding culms, to 3(–8) mm wide, pale to mid-yellow green, somewhat shining; midrib mostly not obvious abaxially except near apex but the abaxial surface of the leaf may be scabrous in big specimens; marginal prickles dense to very sparse, regularly or irregularly spaced (0.2–2.0 mm apart), long to short, 0.05–0.25 mm long, antrorse, aculeate; leaf sheaths not septate-nodulose, ± shining, papery textured, stramineous to pinkish to orange-brown, with wide white-membranous margins. *Inflorescence* simple to compound, 2–15 primary branches 3–18 cm long; bracts erect or spreading, 2–3(–5) much exceeding inflorescence. *Spikelets* mostly numerous (except in subsp. *uniflorus*) in loose to dense, spicate to subdigitate, ovoid to globose clusters of 0.5–2 cm diam.; spikelets terete or laterally compressed, oblong to narrow-ovate, 2.5–12 mm long, 0.3–2(–3) mm wide in side view, 1–8-flowered, often viscid; rachilla not thickened, broadly winged, with the wings 0.10–0.25 mm wide and clasping the nut; glume spacing 2.0–4.7 mm; spikelet usually falling as a unit, or units of ultimate branch plus spikelets falling, or rarely rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic to narrow-obovate, ± excurved, retuse to acute with straight or excurved mucro 0.1–0.4

mm long, pale yellow to dark golden-brown with a narrow green midrib (occasionally scabrous), 2.5–4.5 mm long, 0.5–1.0 mm wide, sides 2–6-nerved, margins inrolled (strongly so in terete spikelets with widely spaced glumes) or not inrolled (subsp. *cheradicus*), margins membranous (mostly broad-hyaline but may not be obvious due to inrolling and viscidity). *Anthers* (0.5–)1.0–2.0 mm long excluding appendage 0.1–0.5 mm long. *Nut* trigonous or triquetrous, very narrow-elliptic to linear or narrow-ovate with acute apex, faces flat to slightly convex, red-brown to black, tuberculate to foveate, glistening, 1.7–3.0 mm long, ⅔ as long as to equalling glume, 0.3–0.7 mm diam., falling with the glume or falling separately from it. Figure 9a–i.

Figure 9. Spikelet details. *Cyperus cunninghamii* subsp. *cunninghamii*: **a**, spikelet; **b**, glume; **c**, nut. *C. cunninghamii* subsp. *cheradicus*: **d**, spikelet; **e**, glume; **f**, nut. *C. cunninghamii* subsp. *uniflorus*: **g**, spikelet; **h**, glume; **i**, nut. *C. astartodes*: **j**, spikelet; **k**, glume; **l**, nut. *C. hesperius*: **m**, spikelet; **n**, glume; **o**, nut. **a–c** from *Latz 2014*; **d–f** *Blake 8754*; **g–i** *Wilson 5302*; **j–l** *Latz 7302*; **m–o** *Beauglehole 48826*. a, d, g, j, m X 11; b, c, e, f, h, i, k, l, n, o X 14.

DISTRIBUTION: Central and northern Australia, extending to the Pilbara and Mt Isa regions of Western Australia and Queensland respectively. Figure 10a–c.

HABITAT: Rocky areas, on ledges, around base of boulders, or in gullies or creeks.

C. cunninghamii differs from all other species in this group in its spikelets, which are often terete (at least when immature, except in subsp. *cheradicus*) and are few-flowered but still relatively long because of the large glume spacing. It differs from *C. astartodes*, *C. microcephalus* and *C. hesperius* in having the rachilla broadly winged. The marginal prickles on the leaves are also distinctive, being long, sparse and antrorsely aculeate. See also notes under *C. astartodes* and *C. centralis*.

As in *C. microcephalus* (q.v.), there is considerable variation within this species, which it has not been possible to explore fully. Tentatively, three subspecies are recognised. Further study may show them to be more appropriately treated as species.

The inflorescence of subspecies *uniflorus* has a distinctive appearance, with clusters of usually few spikelets, the spikelets being terete and one-flowered, with the glume of the fertile flower completely enclosing the rachilla and nut at maturity. However, one-flowered spikelets are also found in subsp. *cunninghamii*, and other differences are quantitative rather than qualitative, leaving the enveloping fertile glume as the only consistent morphological difference between these two taxa. Distributions overlap in the extreme north-east of the Kimberley and in the northern ranges of the Northern

Figure 10. Distribution of: **a**, *C. cunninghamii* subsp. *cunninghamii*; **b**, *C. cunninghamii* subsp. *cheradicus*; **c**, *C. cunninghamii* subsp. *uniflorus*; **d**, *C. astartodes* (crosses) and *C. hesperius* (open circles).

Territory (such as in the Keep River National Park, Katherine Gorge and the McArthur River region). Both subspecies are associated with rocky habitats but there do seem to be minor ecological differences, with subsp. *uniflorus* in drier situations, such as crevices on rock faces, with very shallow soil.

Subspecies *cheradicus* has a more distinctive habitat preference, being found only in stony and sandy beds of seasonal streams. This effectively isolates it from the other subspecies where their distributions overlap (which is only in the extreme north-east of the Kimberley and the McArthur River region of the Northern Territory, so far as known). Its morphology is close to that of subsp. *cunninghamii*. Spikelets are never terete but specimens with similar spikelets are found in subsp. *cunninghamii*. The nut falls separately from the glume but that is owing to the usual lack of viscidity and non-inrolled glume margins in subsp. *cheradicus*: the nuts and glumes are otherwise morphologically very similar to those of subsp. *cunninghamii*.

Subspecies *uniflorus* is vegetatively variable: from tall, relatively robust plants with broad leaves about three-quarters as long as the culms to short, slender plants with filiform leaves about twice as long as the culms. The slender plants are apparently restricted to cliff-faces with minimal soil (and, presumably, also moisture). Inflorescence features are more stable, apparently varying only in degree of branching and length of branches.

Key to subspecies

1 Spikelets always 1-flowered with the fertile glume completely enclosing the nut and rachilla (including upper internodes); inflorescences compound ..... **c.** subsp. **uniflorus**

1 Spikelets 1–8-flowered (if 1-flowered then the rachilla visible opposite the fertile glume, helping to enclose the nut); inflorescences simple to compound **2**

2 Glume and rachilla tightly clasping the nut and falling as a unit; spikelet clusters ± globose; spikelets terete to compressed, 0.7–2.0 mm wide; forming slender tussocks on rocky hillsides ..... **a.** subsp. **cunninghamii**

2 Glume and rachilla not tightly clasping nut, so that nut falls separately from glume; spikelet clusters ± ovoid; spikelets compressed, usually broader (1.5–3.0 mm wide in side view); forming robust tussocks in sandy stream-beds ..... **b.** subsp. **cheradicus**

1a. C. cunninghamii subsp. **cunninghamii**

C. cunninghamii (C.B. Clarke) C. Gardner (1930: 12); Kükenthal (1935–36: 450); Blake (1947a: 37); Wilson (1981: 507, Figure 638F). *Mariscus cunninghamii* C.B. Clarke (1908: 18); Domin (1915: 443).

TYPE: WESTERN AUSTRALIA: Mainland and islands of Dampier Archipelago, NW Coast, *A. Cunningham*, Feb 1818; holo K; iso ?BM (n.v., but cited by Clarke), BRI (fragm.), MEL (n.v., but mentioned by Blake *in litt.*).

C. umbellatus Benth. var. *fasciculiger* F. Muell. in Tate (1896: 181), as 'fasciculigerus'. *C. fasciculiger* (F. Muell.) Domin (1915: 445), in nota. *Mariscus fasciculiger* (F. Muell.) Domin (1915: 443). TYPE: NORTHERN TERRITORY: Central Australia, *R. Tate (Horn Expedition)*, 1894; lecto AD 98438048 (here designated); isolecto AD 98438047, K, NSW 22742. [Type cited as 'On rocky slopes of Mount Tate and in Stuarts Pass'. Lectotype has two field labels: 'Mt T[ate]' and 'Runnels on face Mt Paisley' (Mt Paisley is close to Stuarts Pass).

Mariscus aridicola Domin (1915: 439), as 'aridicolus'. *C. aridicola* (Domin) Domin (1915: 445), as 'aridicolus'; Kükenthal (1935–36: 451). TYPE: QUEENSLAND: in collibus graminosis apud opp. Cloncurry, *Domin 1772*, Feb 1910; lecto PR (here designated).

Mariscus xerophilus Domin (1915: 438, Figure 101). *C. xerophilus* (Domin) Domin (1915: 445), in nota; Kükenthal (1935-36: 450). TYPE: QUEENSLAND: in collibus gramineis prope Cloncurry, *Domin 1765*, Feb 1910; lecto PR (here designated).

[*C. gunnii* auct. non Hook. f.: Bentham (1878: 283), p.p. min.; Ewart & Davies (1917: 55), as to *Walcott* and *Cunningham* specimens]

[*C. holoschoenus* auct. non R. Br.: Fitzgerald (1918: 117), p.p.]

Slender perennial, shallow-rooted, usually viscid towards base of plant and spikelets. *Culms* 1–2(–3.5) mm diam. *Leaves* longer than (rarely to twice as long as) to equalling culms, to 2(–8) mm wide; marginal prickles sparse to very sparse, regularly or irregularly spaced (0.2–2.0 mm apart); sheaths stramineous to pale pink-brown or occasionally orange-brown. *Inflorescence* simple to compound, 2–10(–15) primary branches to 7(–18) cm long; 2–3(–5) bracts much exceeding inflorescence. *Spikelets* numerous in ± dense, spicate to subdigitate, ± globose clusters of 0.5–2 cm diam.; spikelets terete or compressed, oblong to narrow-ovate, 3–12 mm long, 0.7–2.0 mm wide in side view, 1–4(–8)-flowered, mostly viscid at least towards the base; rachilla broadly winged with the wings 0.1–0.15 mm wide and clasping the nut, the rachilla visible in terete spikelets due to wide spacing of the glumes; glume spacing 2.0–4.7 mm; spikelet falling as a unit. *Glumes* oblong to narrow-obovate, ± excurved, retuse to acute with straight or excurved mucro 0.1–0.4 mm long, 2.6–4.5 mm long, 0.5–1.0 mm wide, sides 2–4-nerved, margins inrolled (strongly so in terete spikelets with widely spaced glumes). *Anthers* 0.9–1.5 mm long excluding appendage 0.1–0.2 mm long. *Nut* trigonous to triquetrous, very narrow-elliptic to narrow-elliptic or narrow-ovate, faces flat to occasionally convex, 1.7–2.4 mm long, 0.3–0.6 mm diam., falling with the glume. Figure 9a–c.

DISTRIBUTION: As for the species. Figure 10a.

HABITAT: Rocky hills, on ledges or in gullies.

The type of *C. cunninghamii* was probably collected on Enderby Island (Cunningham's main collecting site in the Dampier Archipelago), on which island B. Maslin recently re-collected the species (*Maslin 5557*), near Cunnningham's probable landing place. Cunningham also collected on Intercourse and Malus Islands and from King Bay on the adjacent mainland, so it is possible that he could have collected the species in one of those places, although Maslin did not find it there (Maslin pers. comm.).

C. umbellatus var. *fasciculiger* was described by Mueller from very immature plants with 1-flowered spikelets. Clarke (quoted by Domin 1915: 443) recognised that this was probably *C. cunninghamii*: 'from the nature of the bristly hairs on the involucral leaves, I think this may be the state of *M.[Mariscus] cunninghamii* before the spikelets have grown out'. Domin (1915) described *C. aridicola* and *C. xerophilus* as having two stamens per flower. I did not dissect any flowers on the type sheets, but I examined all other specimens from Queensland and found three stamens per flower (as is usual in this group).

SELECTED SPECIMENS (118 examined): QUEENSLAND: Burke: Cloncurry, *Blake 6380*, June 1934 (BRI, L, MEL, NSW); Lake Moondarra, NNE of Mt Isa, *Wilson 5427*, May 1983 (NSW, AD, BRI); Lawn Hill Creek near gorge, 16 km SW of Adels Grove, *Wilson 5557*, May 1983 (NSW). NORTHERN TERRITORY: Darwin and Gulf: Katherine Gorge National Park near second rapids, *Craven 6752*, Apr 1981 (CANB, DNA, L); 25 km WSW of Borroloola on Cape Crawford road, *Wilson 5379*, May 1983 (NSW, AD, BRI, CANB, DNA). Victoria River: Tanami Sanctuary, *Henry 661*, Mar 1973 (NT, BRI, CANB). Central North: Aileron Lagoon area, *Chippendale 735*, Dec 1954 (NT, C, CANB, MEL,

NSW); Devils Marbles, 6 miles [10 km] N of Wauchope, *Coveny 517*, Aug 1968 (NSW, BRI, K, NT); Elkedra Station, Davenport Range, *Latz 6954*, May 1977 (NT, AD, NSW). Central South: Penny Springs, George Gill Range, *Beauglehole 26807*, July 1968 (NSW, NT); Longs Range, *Latz 4221*, Aug 1973 (NT, AD, BRI, PERTH). Western Australia: Hall: Picaninny Creek Gorge, 15 km SE of Bungle Bungle Outcamp, Bungle Bungle Range, *Blackwell BB 468*, Apr 1985 (PERTH, NSW). Mueller: Mt Webb, Great Sandy Desert, *De Graaf 67*, May 1977 (PERTH). Fortescue: Mt Edgar Station, SE from Marble Bar, *Burbidge 1101*, June 1941 (BRI, PERTH); 2 miles [3 km] W of Roebourne, *George 3323*, Feb 1962 (PERTH, BRI); Briggada Creek, Barrow Island, *Goodall 1513*, May 1964 (PERTH); Rocky Head, Enderby Island, *Maslin 5557*, Mar 1984 (NSW). Keartland: Little Sandy Desert, *Mitchell 730*, Apr 1979 (NT, NSW, PERTH); Rudall R. area, Curran-Curran Rock Hole, *P. Wilson 10424*, Aug1971 (PERTH, MEL). Giles: Walter James Range, *George 8882*, July 1967 (CANB, K, NSW).

1b. C. cunninghamii subsp. **cheradicus** *K.L.Wilson*, **subsp. nov.**

A subsp. *cunninghamii* nuce glumaque seorsim cadentibus, spiculis semper manifesteque compressis, differt.

Type: Queensland: Gregory North: 20 km NE of Dajarra on Duchess road, *K.L. Wilson 5471*, 17 May 1983; holo NSW; iso BRI, K, NT, P, PERTH. Figure 11a.

[*C. ixiocarpus* auct. non F. Muell.: Blake (1947a: 35), p.p. min. (*Brass 116*)]

Tall but slender perennial, deep-rooted, forming big tussocks, occasionally viscid towards base of spikelets. *Culms* 1.5–2 mm diam. *Leaves* ≤ culms, 2.0–3 mm wide; marginal prickles dense to sparse, regularly spaced (0.2–1.0 mm apart); leaf sheaths ± smooth and shining, orange-brown to stramineous. *Inflorescence* small-compound to compound, 6–11 primary branches to 9 cm long; 2–3 bracts much exceeding inflorescence. *Spikelets* 6–15 in dense, subdigitate, ovoid clusters of 0.7–1.5 cm diam.; spikelets compressed, oblong, 7–10 mm long, 1.5–3.0 mm wide in side view, 2–8-flowered; rachilla broadly winged, wings 0.1–0.25 mm wide, not clasping nut; glume spacing 2.2–3.5 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic, retuse to acute with straight mucro 0.1–0.2 mm long, 3.0–4.5 mm long, c. 0.7 mm wide, sides 3–6-nerved, margins white-membranous and not inrolled. *Anthers* 1.1–2.0 mm long excluding appendage 0.2–0.3 mm long. *Nut* trigonous, narrow-elliptic to narrow-ovate, faces flat to slightly convex, 2.2–3.0 mm long, 0.6–0.7 mm diam., usually falling separately from the glume. Figure 9d–f.

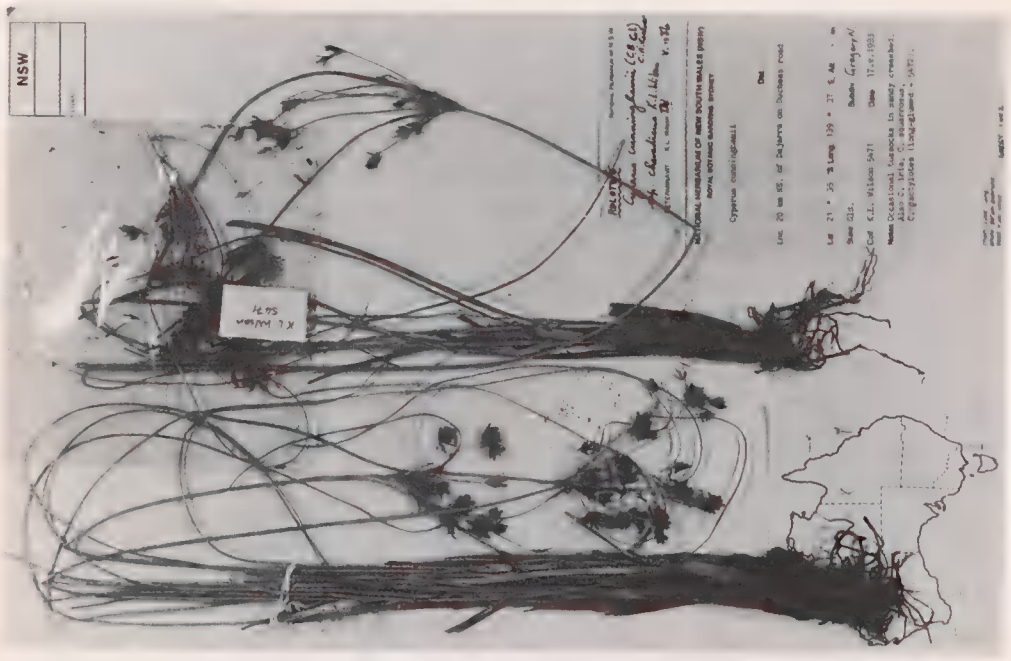
Distribution: Mainly in the Burke and Gregory North regions of Queensland and Darwin & Gulf region of the Northern Territory, extending to the Central North region of the N.T. and the north-eastern Kimberley region of Western Australia (Figure 10b).

Habitat: In sandy and stony beds of seasonal streams.

The epithet comes from the Greek *cheras, cherados*, gravel or silt brought down by a river, referring to the habitat in which this subspecies is found.

Subspecies *cheradicus* differs from the type subspecies in the generally more robust habit (but leaves always canaliculate, never flat); spikelets in ovoid clusters (not globose); the obviously compressed spikelets (but cf. some specimens of subsp. *cunninghamii*), which are mostly broader and less viscid; glume and rachilla not enclosing nut closely (and nut usually falling separately from glume); glume nerves often more numerous and finer, midrib usually thinner, mucro short.

Specimens examined: Queensland: Burke: Dugald R. area, c. 64 km NW of Cloncurry, *Beaumont 7129*, Sep 1971 (BRI); Cloncurry, *Blake 6350*, June 1934 (BRI, K); Leichhardt R., Mt Isa, *Blake 8754*, Apr 1935 (BRI, K, MEL, NSW, NT, PERTH); Coolullah, Leichhardt R., *Blake 9296*, June 1935 (BRI, K); Adels Grove via Camooweal, *De Lestang 276*, Jan 1947 (BRI); Lake Moondarra road, Mt Isa,



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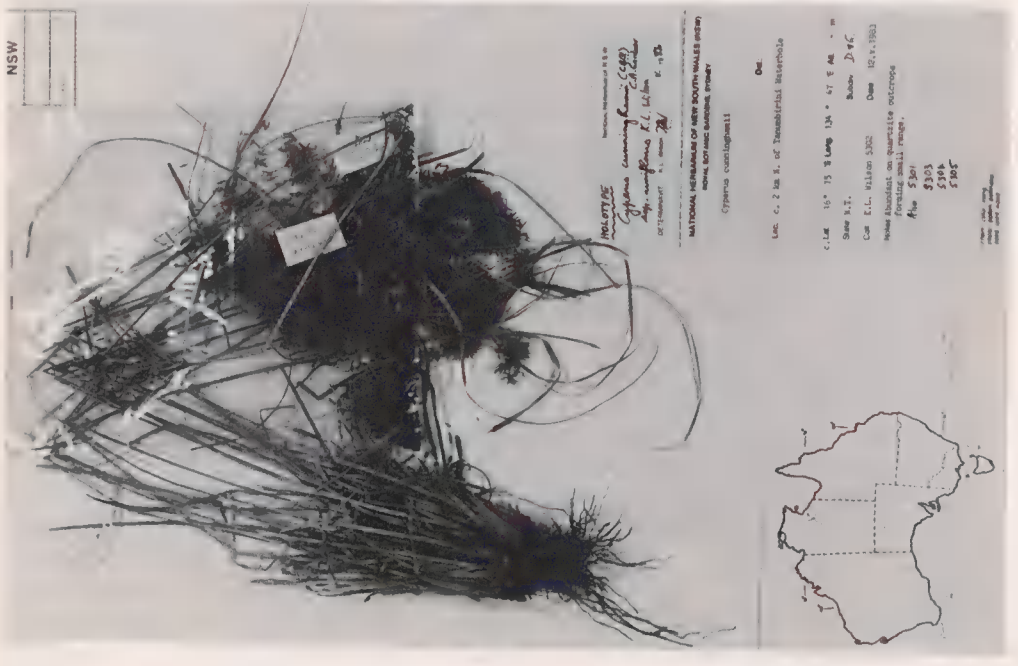


b

Figure 11. Holotype of **a**, *C. cunninghamii* subsp. *cheradicus*; **b**, *C. cunninghamii* subsp. *uniflorus*.

Finlayson 77, 78, Feb 1978 (NSW); Leichhardt R. bed, 2 km W of Coolullah crossing, *Schmid 392*, Feb 1978 (BRI, DNA); 21 km S of Mt Isa on Duchess road, *Wilson 5449*, May 1983 (NSW, BRI, CANB); 13 km NNE of Thorntonia HS. on Burketown road, *Wilson 5495*, May 1983 (NSW, BRI, K); Little Creek, 19 km NW of Riversleigh HS., *Wilson 5542*, May 1983 (NSW, BRI, DNA, PERTH). Gregory North: 22 km N of Wills Creek on Duchess-Mt Isa road, *Wilson 5454*, May 1983 (NSW, AD, BRI, NT); 20 km NE of Dajarra on Duchess road, *Wilson 5471*, May 1983 (NSW). Northern Territory: Darwin and Gulf: Settlement Creek, *Brass 116*, Jan 1922 (BRI, CANB); McArthur R. area, Amelia Springs, *Craven 4201*, June 1976 (CANB). Central North: Old Hatches Creek, *Latz 2221*, Feb 1972 (NSW); 22 km NE of Devils Marbles, *Latz 9491*, Apr 1983 (NSW); Stuart Highway, 8 km N of Wauchope, *Wilson 4668*, Apr 1983 (NSW). Western Australia: Gardner: Granite Creek, 11.7 km SW of Victoria Highway, *Wilson 4894*, Apr 1983 (NSW, AD, DNA, PERTH).

1c. C. cunninghamii subsp. **uniflorus** *K.L. Wilson*, **subsp. nov.**

A subsp. *cunninghamii* spiculis semper unifloribus, gluma fertili nucem rhachillamque perfecte includenti, inflorescentia grande composita, differt.

Type: Northern Territory: Darwin and Gulf: c. 2 km N of Tanumbirini Waterhole, *K.L. Wilson 5302*, 12 May 1983; holo NSW; iso BRI, K, NT, NY, P, PERTH. Figure 11b.

Slender perennial, shallow-rooted, usually viscid towards base of leaves and spikelets. *Culms* 1–2 mm diam. *Leaves* somewhat thickened, somewhat curly, longer than (to twice as long as) or equalling culms, to 3.5 mm wide; marginal prickles dense to very sparse, mostly irregularly spaced (0.4–2.0 mm apart); leaf sheaths pinkish brown to orange-brown. *Inflorescence* compound, 8–15 primary branches to 8 cm long; 2–3 bracts much exceeding inflorescence. *Spikelets* 5–12(–15) in small, loose, subdigitate, hemispherical to globose clusters of 0.5–1.0 cm diam.; spikelets terete, linear, 2.5–4 mm long, 0.3–0.5 mm wide in side view, 1-flowered; rachilla broadly winged, with the wings 0.1–0.2 mm wide and clasping the nut; spikelet falling as a unit usually, or commonly units of ultimate branch plus spikelets falling. *Glumes* very narrow-elliptic, retuse to acute with ± straight mucro <0.1–0.2 mm long, 2.5–3.5 mm long, 0.5–0.6 mm wide, sides 2–4-nerved, margins strongly inrolled and narrow-membranous. *Anthers* 0.5–1.5 mm long excluding appendage 0.2–0.5 mm long. *Nut* triquetrous, very narrow-elliptic to very narrow-ovate, faces flat, 1.7–2.3 mm long, 0.3–0.4 mm diam., falling with the glume. Figure 9g–i.

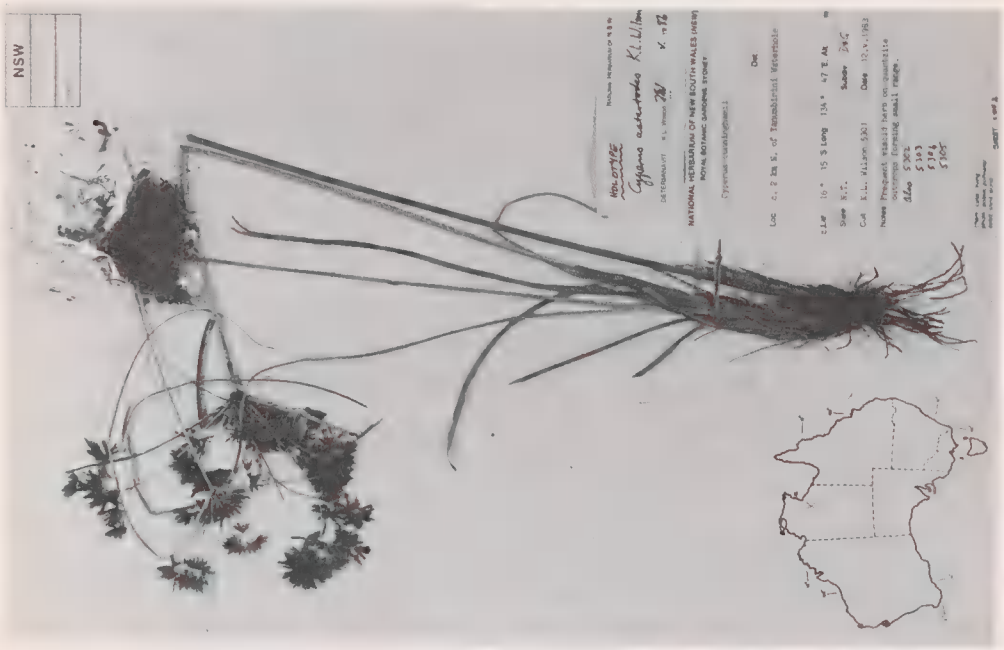
Distribution: Eastern Kimberley region of Western Australia, and Victoria River and Darwin & Gulf regions of the Northern Territory. Figure 10c.

Habitat: In crevices on quartzite outcrops or occasionally at the base of boulders. Specimens growing on rock faces are often weeping in habit, with very long leaves and involucral bracts.

The epithet is from the Latin *unus, -a, -um*, one and *flos, floris*, a flower, referring to the single-flowered spikelets.

Differs from subsp. *cunninghamii* in the always one-flowered spikelets, with the fertile glume completely enclosing the rachilla and nut; the thin midrib and regularly short mucro to the glume; and the usually relatively large compound inflorescence.

Selected specimens (24 examined): Northern Territory: Darwin and Gulf: Hodgson Downs Station, *Blake 17542*, Apr 1947 (BRI, K, L, MEL, NSW); McArthur R. area, sandstone plateau near Glyde R., *Craven 3503*, Jan 1976 (CANB, NT); Katherine Gorge National Park, *Craven 6700*, Apr 1981 (CANB, DNA), *Wilson 5249*, May 1983 (NSW); Bukalara Plateau, NE of Glyde R., *Rice 2339*, Feb 1976 (CANB); Edith Falls, *Wilson 4964*, Apr 1983 (NSW). Victoria River: Jasper Gorge, *Beauglehole & Carr 46580*, July 1974 (ACB, NT); Keep River National Park, *Dunlop 5842*, Mar 1981 (DNA, NSW, PERTH). Western Australia: Gardner: near Kimberley Research Station, *Burbidge 5708, 5709*, Apr 1958 (CANB, BRI, PERTH); sandstone outlier NW of Deception Range, *Hartley 14786*, Mar 1978 (NSW, PERTH); 24 km NE of Dunham River HS., *Lazarides 8524*, Mar 1978 (CANB, BRI, K, L, NSW, NT, PERTH); Hidden Valley, 2.5 km NNE of Kununurra, *Wilson 4790*, Apr 1983



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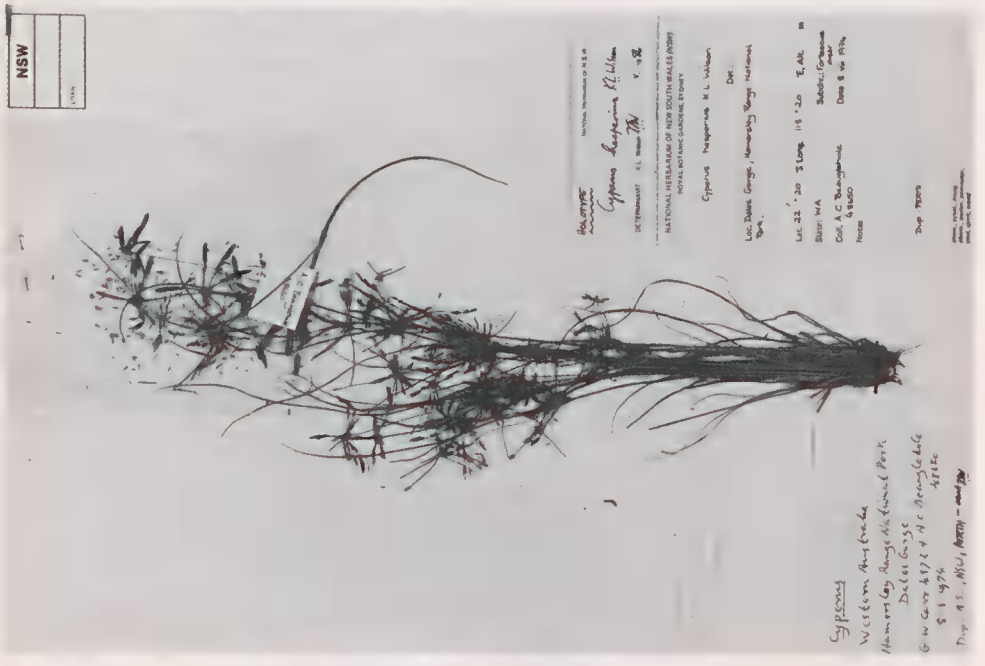


b

Figure 12. Holotype of **a**, *C. astartodes*; **b**, *C. hesperius*.

(NSW); 11 km N of Kununurra just off Weaber Plains road, *Wilson 4805*, Apr 1983 (NSW); 20 km S of Great Northern Highway on Moochalabra Dam road, *Wilson 4864*, Apr 1983 (NSW). Hall: Picaninny Creek Gorge, 15 km SE of Bungle Bungle Outcamp, Bungle Bungle Range, *Blackwell BB 49, 280*, Apr 1985 (NSW, PERTH); SE Kimberley region, summit NE arm Bungle Bungle massif, *Forbes 2636S*, July 1984 (NSW ex MEL).

2. Cyperus astartodes *K.L. Wilson*, **sp. nov.**

C. cunninghamii et *C. microcephali* affinis, sed a *C. cunninghamii* rhachilla exalata differt; a *C. microcephalo* rhachilla non crasso, nuce glumaque seorsim cadentibus, differt.

TYPE: NORTHERN TERRITORY: Darwin and Gulf: c. 2 km N of Tanumbirini Waterhole, *K.L. Wilson 5301*, 12 May 1983; holo NSW; iso BRI, DNA, K. Figure 12a.

C. holoschoenus R. Br. var. *viscidus* W.V. Fitzgerald (1918: 117). TYPE: WESTERN AUSTRALIA: summit of Mt Leake, Lady Forrest Range, *W.V. Fitzgerald 1201*, July 1905; lecto PERTH (here designated); isolecto CANB, NSW.

[*C. cunninghamii* auct. non (C.B. Clarke) C. Gardner: Blake in Specht & Mountford (1958: 202).]

More or less robust perennial, tufted, (30–)50–100 cm high, spikelets often (and base of plant occasionally) viscid. *Culms* terete to trigonous, usually smooth, 2–4.5 mm diam. *Leaves* flat or canaliculate, septate-nodulose, < culms, to 5.5(–11) mm wide; midrib ± obvious abaxially, scabrous or smooth, dark yellow-green; marginal prickles dense to very sparse, mostly regularly spaced (0.2–1.7 mm apart), short, 0.05–0.10 mm long, erect to antrorse or occasionally retrorse, papillate to aculeate; leaf sheaths not septate-nodulose, finely striate but somewhat shining, stramineous to pale orange-brown. *Inflorescence* compound to decompound, 9–20 primary branches to 19 cm long; bracts spreading, 2–5 much exceeding the inflorescence. *Spikelets* 3–7 in rather loose, subdigitate, hemispherical clusters of 0.8–3 cm diam.; spikelets compressed, oblong, 6-19 mm long, 1.5–2.0 mm wide in side view, 3–8(–22)-flowered, often viscid; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing (1.3–)1.5–2.1 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic, obtuse to acute with straight mucro 0.1–0.2 mm long, golden-brown to red-brown, 2.2–2.7 mm long, 0.5–0.6 mm wide, sides 2–3-nerved, margins slightly inrolled and broad-hyaline. *Anthers* 0.7–1.2 mm long excluding appendage <0.1–0.2 mm long. *Nut* trigonous to triquetrous, very narrow-elliptic to narrow-ovate with acute apex, faces flat, pale brown to red-brown or occasionally dark red-brown, smooth and reticulate-areolate or tuberculate, glistening, 1.5–2.1 mm long, ⅞ as long as to equalling glume, 0.3–0.5 mm diam., falling with the glume. Figure 9j–l.

DISTRIBUTION: Gardner and Fitzgerald regions of Western Australia to Darwin & Gulf and Barkly Tableland of the Northern Territory. Figure 10d.

HABITAT: Sandy soils; around rock outcrops in open woodland or on open rocky slopes.

The epithet is derived from the name of the Phoenician goddess of fertility and love, Astarte, and the Greek *-odes*, resembling or like, referring to the large, floriferous inflorescences. Fitzgerald's varietal epithet was not taken up because there could be confusion with *C. viscidulus*. Also, it is not particularly appropriate for this species, which is only occasionally viscid.

Differs from *C. cunninghamii* in its generally robust habit with large compound inflorescence, always compressed spikelets (and generally broader) with more flowers,

often wingless rachilla, generally shorter glumes, its marginal prickles, and generally paler nut (although darker and broader in *Wilson 5151*).

From *C. microcephalus*, it differs in its more robust habit, longer glumes, usually greater glume spacing, rachilla not thickened, glumes clasping nut, sparse variable marginal prickles on the leaves, nut paler and longer, and often viscid spikelets (and occasionally plant base as well).

The species occasionally occurs with *C. cracens* (q.v.).

Specimens examined: Northern Territory: Darwin and Gulf: Hodgson Downs Station, *Blake 17543*, Apr 1947 (BRI, K, NSW); O.T. Station, *Blake 17678*, May 1947 (BRI, K, NSW); Mt Brockman near Koongarra Saddle, *Craven 5744*, May 1980 (CANB); Katherine Gorge National Park, *Dunlop & Byrnes 2165*, Mar 1971 (BRI, CANB, DNA, NT); Nicholson R. area, near Fish R. gorge in China Wall, *Kanis 1760*, June 1974 (CANB, NT); Tanumbirini Creek, Cox River Station, *Latz 7302*, July 1977 (NT, BRI, NSW); SW Island, *McKey 199*, May 1977 (NT, NSW); Buchanan Bay, *McKey 203*, May 1977 (NT, BRI, NSW); South Bay, Bickerton Island, *Specht 649*, June 1948 (CANB, BRI, K, MEL, NSW, PERTH); 50 km E Oenpelli, *Wightman 679*, Aug 1983 (DNA); Edith Falls, *Wilson 4965*, Apr 1983 (NSW); c. 17 km N of Mudginberri turn-off on Oenpelli road, *Wilson 5151*, May 1983 (NSW). Western Australia: Gardner: Rocky Creek, c. 60 km N of Drysdale River, *Benson 2088a*, July 1984 (NSW); Cave Hill Range, near Kununurra, *Wolfe & Martin 37*, May 1970 (CANB). Fitzgerald: *Fitzgerald 1201* (PERTH, CANB, NSW); Mt Barnett Station, summit escarpment Barnett Range, *Forbes 2750*, July 1984; Durack River, *Hartley 14652*, Mar 1978 (CANB, NT, PERTH).

3. Cyperus hesperius *K.L. Wilson*, **sp. nov.**

C. microcephali affinis sed glumis latioribus ellipticisque, marginibus glumae latiore hyalinis, foliis non crispatis, marginibus foliorum papillosis, differt.

Type: Western Australia: Fortescue: Dales Gorge, Hamersley Range National Park, *A.C. Beauglehole 48650 & G.W. Carr 4872*, 8 Aug 1974; holo NSW; iso ACB, NT, PERTH. Figure 12b.

Slender perennial, tufted, 30–40 cm high, not viscid. *Culms* terete to trigonous, smooth, 1–1.5 mm diam. *Leaves* canaliculate, not septate-nodulose, shorter than culms, to 2.5 mm wide; midrib occasionally obvious abaxially; marginal prickles dense, regularly spaced (0.05–0.3 mm apart), very short to short, no more than 0.05 mm long, erect to slightly antrorse, papillate; leaf sheaths not septate-nodulose, ± smooth and shining, stramineous to pale pink-brown. *Inflorescence* simple or small-compound, (1–)4–7 primary branches to 11 cm long; bracts erect to spreading, 2–4 exceeding the inflorescence. *Spikelets* 6–20 in loose subdigitate, hemispherical clusters of 2–5 cm diam.; spikelets compressed, oblong, 8–25 mm long, 2 mm wide in side view, (4–)8–26-flowered; rachilla thickened at maturity (to 0.2 mm thick), not or narrowly winged, wings to 0.05 mm wide; glume spacing 1.5–1.8 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic to narrow-ovate, retuse to acute, with straight mucro 0.2–0.3 mm long, golden-brown to red-brown with green midrib, 2.4–2.8 mm long, 0.5–0.6 mm wide, sides 2–3-nerved, margins broad- to narrow-hyaline and mostly not inrolled. *Anthers* 0.3–0.8 mm long excluding appendage 0.2–0.4 mm long. *Nut* trigonous to triquetrous, narrow-elliptic (to narrow-ovate) with acute apex, faces flat, red-brown to black, small-colliculate to tuberculate, glistening, 1.5–1.8 mm long, ⅔ – ¾ as long as glume, 0.4–0.5 mm diam., mostly falling with glume. Figure 9m–o.

Distribution: Pilbara region of Western Australia. Figure 10d.

Habitat: On open rocky hillsides so far as known.

The epithet is derived from the Greek *hesperios*, at eventide or towards the setting sun, and hence by transference western, referring to the species' occurrence only in the Pilbara region of Western Australia.

Allied to *C. microcephalus*, especially the type subspecies (which also occurs in the Pilbara), but differing from it in its broader elliptic glumes with broader hyaline margins, and its straight (not curly) leaves with papillate margins. *C. cunninghamii* subsp. *cunninghamii* also grows in the Pilbara, but differs in its broadly winged rachilla and its sparse, long prickles on the leaf margins.

Specimens examined: Western Australia: Fortescue: 61 km SE of Port Hedland on Marble Bar road, *Beauglehole 11352*, Aug 1965 (NSW, NT); Dales Gorge, Hamersley Range National Park, *Beauglehole 11490*, Aug 1965 (ACB), *George 3575*, Mar 1962 (BRI, NSW); Chichester National Park, Python Pool, *Beauglehole 48826 & Carr*, Aug 1974 (NT); Robe R. between Onslow and Roebourne, *Butler 29*, Aug 1966 (PERTH); 16 km SSW of Two Sisters, c. 180 km SE of Shay Gap, *Newbey 10410*, July 1984 (PERTH); Abydos Station, S of Port Hedland, *Richardson 29*, Sep 1968 (PERTH); Hamersleys, Wittenoom Gorge, *Symon 10034*, May 1975 (PERTH).

4. Cyperus microcephalus *R. Br.*
Brown (1810: 215)

Perennial, generally slender, tufted, 20–85 cm high, not viscid. *Culms* terete to trigonous, often strongly scabrous at least near apex, 0.3–4 mm diam. *Leaves* flat, or canaliculate in slender specimens, may be septate-nodulose in large specimens, shorter than to longer than culms, to 7 mm wide, yellow-green; midrib obvious abaxially (and then usually scabrous) or not obvious; marginal prickles very dense, regularly spaced (<0.05–0.5 mm apart), very short to short, <0.05–0.10 mm long, antrorse, aculeate; leaf sheaths may be septate-nodulose in large specimens, smooth or finely striate, not shining, stramineous to salmon-coloured or orange-brown. *Inflorescence* simple to decompound, 0–15 primary branches 1–14 cm long; bracts erect to spreading, 1–7 exceeding the inflorescence. *Spikelets* 3–15 in loose subdigitate, hemispherical clusters of 0.5–1.5(–5.0) cm diam.; spikelets compressed, ± oblong, 3–10(–30) mm long, 1.0–3.0 mm wide in side view, 3–10(–32)-flowered; rachilla usually thickened at maturity (to 0.3 mm thick), not to rarely broadly winged, with wings to 0.15 mm wide; glume spacing 0.8–2.1 mm; spikelet falling as a unit, or with rachilla persistent and glumes falling individually, or units of ultimate branch plus spikelets falling. *Glumes* narrow-elliptic to very narrow-ovate, acute to obtuse or retuse with straight or slightly excurved mucro <0.1–0.4 mm long, stramineous to dark golden- or pale red-brown (often with yellow blotches, especially when young), with a green midrib, 1.2–3.6 mm long, 0.2–0.7 mm wide, sides 1–4-nerved, margins very narrow-membranous and not inrolled. *Anthers* 0.3–1.0 mm long excluding appendage 0.1–0.6 mm long. *Nut* trigonous to triquetrous, narrow-obovate to narrow-ovate with acute apex, faces concave to flat, red-brown to black, smooth or tuberculate or colliculate, glistening or shining, 1.3–1.8 mm long, from half as long as to slightly exceeding the glume, 0.2–0.7 mm diam., falling separately from glume. Figure 13a–i.

Distribution: Northern Australia, extending to the Pilbara region of Western Australia and North Kennedy District of Queensland. Figures 14a–c.

Occasionally found growing near *C. cunninghamii* or *C. astartodes* (q.v.) but readily distinguished from them by its thickened rachilla, the shorter anthers with long appendage, and the short dense prickles on the leaf margins. In addition, the glumes in *C. microcephalus* have very narrow margins, which are not inrolled, and the nut falls separately from the associated glume. These features are shared by the three taxa treated here as subspecies, with differences between the taxa being quantitative as

much as qualitative. Despite some overlaps in distribution, the taxa are, I believe, best treated as subspecies, at least pending further study.

Subspecies *chersophilus* is more clearly defined morphologically than subsp. *saxicola*. In addition, subsp. *chersophilus* is more distinct than the other subspecies in its habitat preference and geographical distribution.

Subspecies *saxicola* may represent no more than a depauperate form (or forms) of subspecies *microcephalus* but it does seem to be consistently different from the latter in its curly leaves, slender habit, and triquetrous nut with flat faces. Specimens from Arnhem Land differ further somewhat (see below under subsp. *saxicola*) and may represent a separate taxon. Subspecies *saxicola* occurs in close proximity to subsp. *microcephalus* in various localities on the south-western margin of Arnhem Land (e.g. Edith Falls and Katherine Gorge) and to the south-east (Caranbirini Waterhole and

Figure 13. Spikelet details. *C. microcephalus* subsp. *microcephalus*: **a**, spikelet; **b**, glume; **c**, nut. *C. microcephalus* subsp. *chersophilus*: **d**, spikelet; **e**, glume; **f**, nut. *C. microcephalus* subsp. *saxicola*: **g**, spikelet; **h**, glume; **i**, nut. *C. crispulus*: **j**, spikelet; **k**, glume; **l**, nut. *C. sexflorus*: **m**, spikelet; **n**, glume; **o**, nut. **a–c** from *Dunlop 5325*; **d–f** *Wilson 4890*; **g–i** *Latz 2734*; **j–l** *Dunlop 4441*; **m-o** *De Lestang 338*. a, d, g, j, m X 11; b, c, e, f, h, i, k, l, n, o X 14.

the McArthur River region). However, there appear to be minor differences in habitat, with subsp. *saxicola* being in slightly drier situations, such as crevices on rock faces, with very shallow soil. The distribution of subsp. *saxicola* is interrupted: no specimens are known from the north-east Kimberley and the Victoria River region of the Northern Territory. There would appear to be suitable habitats in those areas for the subspecies, which may indicate inadequate collecting or perhaps a taxonomic problem. Further field study is needed to resolve this.

Bentham (1878) considered that *C. sexflorus* and *C. sporobolus* might be no more than varieties of this species (based solely on R. Brown's rather immature specimens). However, the bulbous culm-bases of these two species readily distinguish them from *C. microcephalus*.

Key to subspecies

1 Leaves flat (or canaliculate when slender) with abaxial midrib obvious and usually scabrous, not curly, (1.0–)1.5–7 mm wide; culms to 4 mm diam., [mostly strongly scabrous at least near apex]; inflorescence small-compound to decompound with primary branches to 14 cm long; nut faces concave or occasionally flat ..... **a.** subsp. **microcephalus**

1 Leaves canaliculate (occasionally flat in subsp. *chersophilus*), curly, 0.3–2.0 mm wide; culms no more than 1.5 mm diam.; inflorescence usually simple, with primary branches to 8 cm long; nut faces flat **2**

2 Glumes (2.0–)2.4–3.6 mm long; culms usually scabrous; spikelets (6–)10–30 mm long,2.0–3.0 mm wide in side view; nut trigonous, no more than ¾ glume length ..... **b.** subsp. **chersophilus**

2 Glumes 1.0–2.0 mm long; culms smooth; spikelets 3–11 mm long, 1.2–2.0 mm wide in side view; nut triquetrous, as long as or slightly exceeding nut ..... **c.** subsp. **saxicola**

4a. C. microcephalus subsp. **microcephalus**

C. microcephalus R. Brown (1810: 215); Poiret (1817: 187); Sprengel (1824: 227); Kunth (1837: 111); Steudel (1854: 54); Domin (1915: 432). *C. sporobolus* var. *microcephalus* (R. Br.) Benth. ex Kükenthal (1935-36: 457).

Type: Northern Territory: Carpentaria island h [North Island, Sir Edward Pellew Group], *R. Brown (Bennett 5902)*; lecto BM (here designated); isolecto BM, BRI (fragm.), K.

[*C. distans* auct. non L.f.: Fitzgerald (1918: 117)]

[*C. fulvus* auct. non R. Br.: Mueller (1874: 268), p.p.]

[*C. holoschoenus* auct. non R. Br.: Fitzgerald (1918: 117), p.p. (Denham River)]

[*C. sporobolus* auct. non R. Br.: Bentham (1878: 281), p.p. min.; Ewart & Davies (1917: 56), p.p. min.; Fitzgerald (1918: 117), p.p. min. (*Hughan*, NW Coast)]

Tall but slender perennial, 25–85 cm high. *Culms* usually strongly scabrous at least near apex, 0.7–4 mm diam. *Leaves* flat, or occasionally canaliculate in slender specimens, septate-nodulose in large specimens, ≤ culms, (1.0–)1.5–7 mm wide; midrib usually obvious abaxially and scabrous; leaf sheaths may be septate-nodulose in large specimens, stramineous to pink-brown. *Inflorescence* usually large, small-compound to decompound, spreading, 4–15 primary branches to 14 cm long; bracts erect to spreading, 3–7 exceeding the inflorescence. *Spikelets* 3–8 in loose clusters of 0.8–1.5 cm diam.; spikelets 3–7(–15) mm long, 1.0–2.5 mm wide in side view, 3–10(–26)-

flowered; rachilla not to rarely broadly winged, wings 0.05–0.10 mm wide; glume spacing 0.8–1.6 mm. *Glumes* narrow-elliptic to narrow-ovate, acute to obtuse with straight mucro <0.1–0.2 mm long, 1.5–2.0 mm long, 0.4–0.6 mm wide, sides 2–4-nerved. *Anthers* 0.5–1.0 mm long excluding appendage 0.2–0.6 mm long. *Nut* trigonous to triquetrous, narrow-obovate to narow-ovate, faces concave or occasionally flat, red-brown to very dark red-brown, smooth and reticulate-areolate or tuberculate, shining or glistening, about as long as the glume, 0.4–0.7 mm diam. Figure 13a–c.

Figure 14. Distribution of: **a**, *C. microcephalus* subsp. *microcephalus*; **b**, *C. microcephalus* subsp. *chersophilus*; **c**, *C. microcephalus* subsp. *saxicola*; **d**, *C. crispulus*; **e**, *C. sexflorus*; **f**, *C. portae-tartari*.

DISTRIBUTION: As for the species. Figure 14a.

HABITAT: Amongst boulders on hillsides or on scree slope at base of cliffs.

This subspecies usually has very dense prickles on the leaf margins, but they are occasionally sparser, for example at the eastern end of its range in Queensland (*Sharpe 2784, 2868*). Queensland specimens also tend to have larger glumes. *Sharpe 2891* (Burdekin River close to Keelbottom Mountain) and *Blake 11703* (Charters Towers) probably belong here but have longer glumes (2.3–2.6 mm long) with finer nervation, and leaf margins with sparser but long antrorse and/or flabellate prickles.

SELECTED SPECIMENS (99 specimens examined): QUEENSLAND: Burke: Mt Isa, *Blake 8800*, Apr 1935 (BRI, K, L, MEL); Gregory Range E of Croydon, *Blake 19666*, July 1954 (BRI). North Kennedy: Burdekin R., 40 km N of Charters Towers, 2 km S of Keelbottom Mountain, *Sharpe 2784*, June 1981 (BRI, NSW); Red Falls, on Lolworth R., 55 km NW of Charters Towers, *Sharpe 2868*, July 1981 (BRI, NSW). NORTHERN TERRITORY: Darwin and Gulf: N side of Mt Brockman, *Craven 2348*, Feb 1973 (CANB, BRI, NT, PERTH); McArthur R. area, near the Glyde R., *Craven 3561*, Jan 1976 (CANB); South West I., Sir Edward Pellew Group, *Craven 3751*, Feb 1976 (CANB, BRI, L, NT); Wessel Islands, *Latz 3478*, Oct 1972 (BRI, CANB, NT); Katherine Gorge National Park, *Wilson 5251*, May 1983 (NSW, DNA); Maude Creek goldfield, 32 km E of Katherine, *I. Wilson 174*, Jan 1965 (CANB, BRI, L, NT). Victoria River: hills above and to E of Victoria R., old crossing, Bynoe Range, *Carolin 6624*, May 1968 (SYD); Keep River National Park, *Dunlop 5735*, Feb 1981 (DNA, NSW, NT). Barkly Tableland: 27 miles [43 km] E of Alexandria Station, *Perry 1503*, June 1948 (CANB, BRI, K, MEL, NT). WESTERN AUSTRALIA: Gardner: Mitchell Plateau, *Beard 8429*, Feb 1979 (PERTH, NSW); Boiga Falls, Drysdale R. National Park, *Kenneally 3022*, Aug 1975 (PERTH); Hidden Valley, 2.5 km NNE of Kununurra, *Wilson 4795*, Apr 1983 (NSW); Osborne I. (South West I.), Bonaparte Archipelago, *P. Wilson 11042*, June 1973 (PERTH). Dampier: 160 km SW of Anna Plains, *Beauglehole 11317*, Aug 1965 (NT, PERTH). Fitzgerald: 14 km N of Napier Range, *Symon 10136*, May 1975 (BRI, PERTH). Hall: Picaninny Creek Gorge, 15 km SE of Bungle Bungle Outcamp, Bungle Bungle Range, *Blackwell BB 336*, June 1985 (NSW, PERTH). Fortescue: 4 km SW of Shay Gap (town), c. 165 km E of Port Hedland, *Newbey 10255*, July 1984 (PERTH).

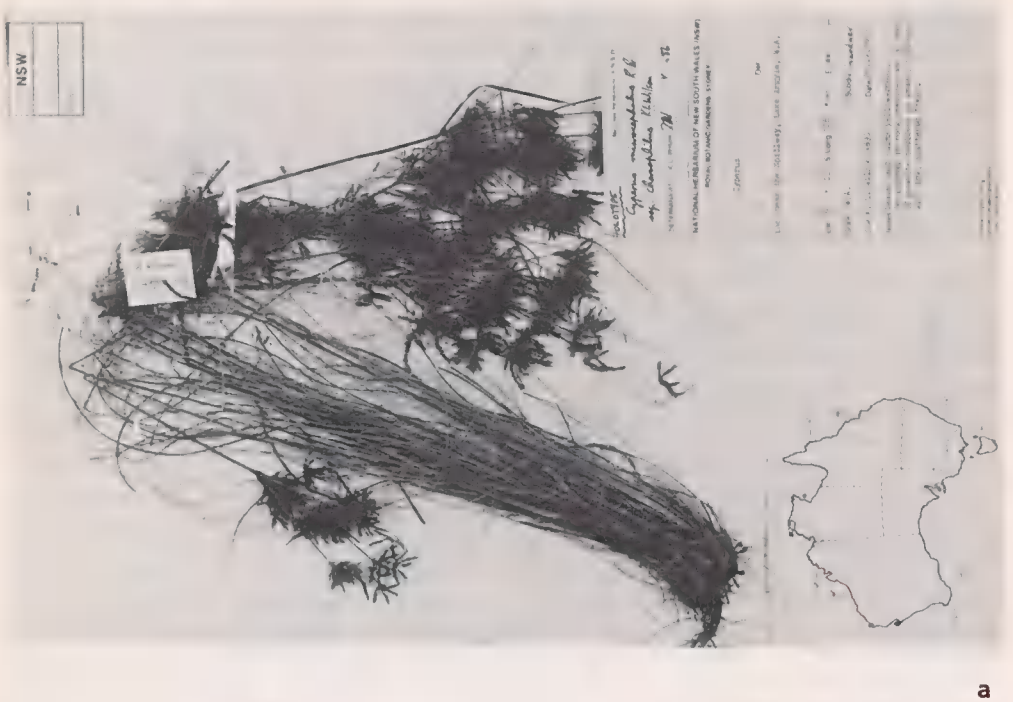
4b. C. microcephalus subsp. **chersophilus** *K.L. Wilson*, **subsp. nov.**

A subsp. *microcephalo* foliis crispatis, plerumque glumis spiculisque longioribus, differt.

TYPE: WESTERN AUSTRALIA: North Kimberley: near the Spillway, Lake Argyle, *K.L. Wilson 4890*, 26 Apr 1983; holo NSW; iso AD, BRI, CANB, DNA, K, NY, P, PERTH. Figure 15a.

Slender perennial, 25–50 cm high. *Culms* usually scabrous at least near apex, 0.5–1.5 mm diam. *Leaves* canaliculate or occasionally flat, somewhat curly, not septate-nodulose, shorter than culms, to 2 mm wide; midrib occasionally obvious abaxially and usually smooth; leaf sheaths not septate-nodulose, salmon-coloured or orange-brown. *Inflorescence* simple, 0–8 primary branches 2–8 cm long; bracts erect to spreading, 1–3 exceeding the inflorescence, often curly. *Spikelets* 6–15 in large, sparse clusters of 1–5 cm diam.; spikelets (6)–10–30 mm long, 2.0–3.0 mm wide in side view, (4–)6–32-flowered; rachilla not winged; glume spacing 1.2–1.7(–2.1) mm. *Glumes* very narrow-ovate to narrow-ovate, acute with straight or slightly excurved mucro (0.1–)0.2–0.4 mm long, (2.0–)2.4–3.6 mm long, 0.3–0.5(–0.7) mm wide, sides 2–3(–4)-nerved. *Anthers* 0.3–1.1 mm long excluding appendage 0.2–0.4 mm long. *Nut* trigonous, narrow-elliptic, faces flat, red-brown to dark red-brown, tuberculate to slightly elongate-colliculate, shining, ½ – ¾ as long as the glume, 0.3–0.4 mm diam. Figure 13d–f.

DISTRIBUTION: From the Kimberley region of Western Australia to the Darwin & Gulf and Barkly Tableland regions of the Northern Territory. Figure 14b.



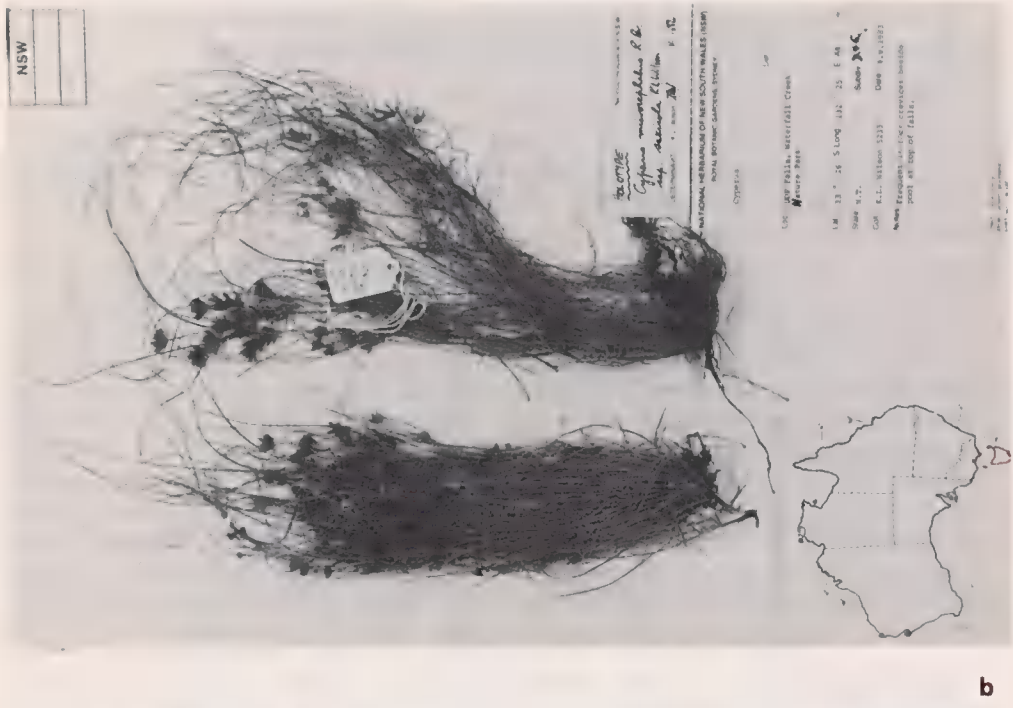


Figure 15. Holotype of **a**, *C. microcephalus* subsp. *chersophilus*; **b**, *C. microcephalus* subsp. *saxicola*.

HABITAT: On open hillsides, amongst boulders and hummock grasses or in rock crevices.

The epithet is derived from the Greek *chersos*, dry land, and *phileo*, to love, referring to the habitat of the subspecies.

Differs from subspecies *microcephalus* and *saxicola* in the long, narrow glumes in the generally long spikelets. Also differs from subsp. *microcephalus* in the curly, narrow, canaliculate leaves.

SELECTED SPECIMENS (30 examined): NORTHERN TERRITORY: Darwin and Gulf: O.T. Station, *Blake 17679*, May 1947 (BRI, K, L, MEL, NSW); Nicholson R. area, near Fish R. gorge in China Wall, *Kanis 1755*, June 1974 (CANB, K, NT). Victoria River: Gardner Range, NW Tanami Desert, *Latz 8620*, Apr 1981 (NSW, NT); 4 km S Timber Creek Racecourse, *Must 1560*, July 1979 (NT); 20 miles [32 km] N Victoria R. Downs Station, *Perry 2117*, June 1949 (BRI, CANB). Barkly Tableland: Newcastle Waters, *Latz 5996*, May 1975 (BRI, NSW, NT). WESTERN AUSTRALIA: Gardner: S side of Cockburn Range, c. 6.5 km W of King R., *Beauglehole & Carr 47196*, July 1974 (NSW, NT); headwaters Packsaddle Creek, N Carr Boyd Ranges, *Hartley 14341*, Mar 1978 (CANB, PERTH); Ord R. Dam, *Latz 5444*, June 1974 (NSW); vicinity of Kimberley Research Station, *Mackenzie 690315*, 1969 (CANB); Lake Argyll, *Must 1276*, Sep 1974 (NSW, NT, PERTH); near the Spillway lookout, Lake Argyle, *Wilson 4891*, Apr 1983 (NSW). Dampier: Windjina Gorge, Napier Range, *Beauglehole & Carr 47686*, July 1974 (ACB). Fitzgerald: Lennard R. Gorge, King Leopold Range, *Beauglehole & Carr 47752*, July 1974 (NSW, NT); Mabel Downs, Winnama Gorge, *Chesterfield 211*, May 1984 (NSW ex MEL); Mount Eliza, West Kimberley, *Fitzgerald*, May 1905 (NSW 153243), *Fitzgerald 735*, May 1905 (PERTH); c. 17.5 km S of Turkey Creek, Winnama Spring, *Willis*, May 1984 (NSW 166822 ex MEL). Hall: Halls Creek, *Mullumby*, May 1972 (PERTH); 18.5 miles [30 km] WSW of Lissadell Station, *Perry 2678*, Aug 1949 (BRI, CANB).

4c. C. microcephalus subsp. **saxicola** *K.L. Wilson*, **subsp. nov.**

A subsp. *microcephalo* foliis crispatis, bracteis involucralibus longis, habitu gracile, nuce triquetro, differt.

TYPE: NORTHERN TERRITORY: Darwin and Gulf: UDP Falls, Waterfall Creek Nature Park, *K.L. Wilson 5233*, 9 May 1983; holo NSW; iso DNA, K. Figure 15b.

[*C. castaneus* Willd. form: Hamilton in Ewart & Davies (1917: 288)]

Slender perennial, 20–40 cm high. *Culms* smooth, 0.3–1.0 mm diam. *Leaves* thickened, canaliculate, somewhat curly, not septate-nodulose, often longer than the short culms, to 1.3 mm wide; midrib not obvious; leaf sheaths not septate-nodulose, salmon-coloured. *Inflorescence* small, simple or occasionally small-compound, (2–)4–7(–12) primary branches to 2–5 cm long; bracts erect, mostly curly towards apex, 2–4 much exceeding the inflorescence (occasionally longer than the culms). *Spikelets* few in clusters of 0.5–1.2 cm diam.; spikelets 3–8(–11) mm long, 1.2–2.0 mm wide in side view, 4–8(–12)-flowered; rachilla not or rarely broadly winged, wings 0.05–0.15 mm wide; glume spacing 0.8–1.2(–1.5) mm. *Glumes* very narrow-oblong to very narrow-ovate, acute to retuse with straight mucro 0.1–0.3 mm long, 1.0–2.0 mm long, 0.2–0.5 mm wide, sides 1–3-nerved. *Anthers* 0.3–1.0 mm long excluding appendage 0.1–0.4 mm long. *Nut* triquetrous, very narrow-elliptic to narrow-elliptic, faces flat, dark red-brown to black, tuberculate or shortly elongate-colliculate, glistening, about as long as or exceeding the glume, 0.2–0.5 mm diam. Figure 13g–i.

DISTRIBUTION: From the Kimberley region of Western Australia to the western edge of the Burke region, Queensland. Figure 14c.

HABITAT: In rock crevices on rock outcrops. Specimens growing on rock faces are often of weeping habit.

The epithet is derived from the Latin *saxum*, a rock, and *-cola*, a dweller or inhabitant, in reference to the habitat of the subspecies. As with all epithets ending in *-cola*, this

should be treated as a noun in apposition, i.e. the ending does not vary with the gender of the associated generic name.

Most specimens from Arnhem Land differ from the rest in having culms much shorter than the involucral bracts, glumes that are usually shorter (1.0–1.4 mm long) and relatively broader (0.3–0.5 mm wide) and more elliptical than oblong in side view, and nuts that are usually shorter (1.1–1.5 mm long) and relatively broader (0.3–0.5 mm diam.). More typically, the subspecies has culms longer than or equalling the involucral bracts, glumes (1.3–)1.5–2.0 mm long and 0.2–0.5 mm wide, and nuts (1.3–)1.4–1.8 mm long and 0.2–0.3(–0.5) diam. Further study is needed to determine whether the Arnhem Land material represents a separate taxon or just an ecologically induced extreme.

This subspecies differs from subsp. *microcephalus* in its curly leaves, slender habit and triquetrous nut with flat faces. It can be found growing near subsp. *microcephalus*, but usually in different microhabitats. For example, *Wilson 5202* (subsp. *microcephalus*) and *5203* (subsp. *saxicola*) from Moline Rockhole, Northern Territory: the former subspecies was growing at the base of rock outcrops beside a creek and the latter in shallower soil in rock crevices beside the creek and up the slope.

Selected specimens (75 examined): Queensland: Burke: Hells Gate near Westmoreland, *Carolin 9170*, May 1974 (SYD, K), *Jacobs 1535*, May 1974 (NSW). Northern Territory: Darwin and Gulf: Katherine Gorge, *Blake 17209*, Oct 1946 (BRI), *Jacobs 3755*, Apr 1980 (NSW); Cahills Crossing, East Alligator R., *Blake 17124*, Oct 1946 (BRI); Borroloola, *Hill 596*, Nov 1911 (MEL, NSW); 24 miles [38 km] N Mainoru, *Latz 2734*, June 1972 (NSW); Edith Falls, *Latz 3102*, July 1972 (NSW), *Wilson 4962*, Apr 1983 (NSW, AD, BRI, CANB, DNA, H, K, L, MEL, P, PERTH, UB); Cox R. Station, Tanumbirini Creek, *Latz 7308*, July 1977 (NT, BRI, NSW); 4 miles [6 km] NE Mountain Valley HS., *Nelson 185*, Apr 1962 (NT, CANB, MEL, NSW); 8 km W of Roper Bar, *Parker 911*, June 1977 (DNA, BRI, CANB, DNA); Robin Falls, *Wilson 5026*, Apr 1983 (NSW, AD, BRI, NT, P, PERTH); Sculthorpe Pound, *Latz 10129*, Aug 1985 (NSW); Alligator Yard, c. 20 km NW of Bauhinia Downs Station, *Leach 565*, May 1985 (NSW). Barkly Tableland: 20 km SSW of Wollogorang Homestead, *Latz 11210*, Jan 1989 (NSW). Western Australia: Gardner: Mitchell R., *Dunlop 5234*, Feb 1980 (DNA, NSW); Surveyor Fall near Mitchell R., *George 13144*, June 1975 (PERTH); Augustus I., Bonaparte Archipelago, *P. Wilson 10720*, May 1972 (PERTH); Boongaree I., Prince Frederick Harbour, *P. Wilson 11337*, July 1973 (PERTH). Fitzgerald: Hidden I., Buccaneer Archipelago, *Kenneally 8371, 8392*, June 1982 (PERTH).

The following specimens are referable to the Arnhem Land 'form':

Mt Brockman, 13 km S of Jabiru East, Site 122, *Craven 6492*, June 1980 (CANB, DNA, L, NSW); ESE Mudginberry, *Dunlop 3306*, Feb 1973 (DNA, NT); East Alligator R. (top of sandstone escarpment), *Dunlop 3347*, Feb 1973 (DNA, NT); Little Nourlangie Rock, *Dunlop 4728*, Mar 1978 (DNA, NSW, NT), *Wilson 5191*, May 1983 (NSW, DNA); Arnhem Land, 12° 52'S 134° 32'E, *Latz 2996*, June 1972 (NSW); Nourlangie Rock, *Rice 2575*, May 1978 (DNA); Koongarra, *Rice 3263*, Apr 1981 (CANB, NSW); Liverpool R. headquarters, *Wightman 1432 & Craven*, Apr 1984 (DNA, BRI, NSW); Bauhinia Downs Station, *Wightman 1841 & Leach*, May 1985 (DNA, NSW).

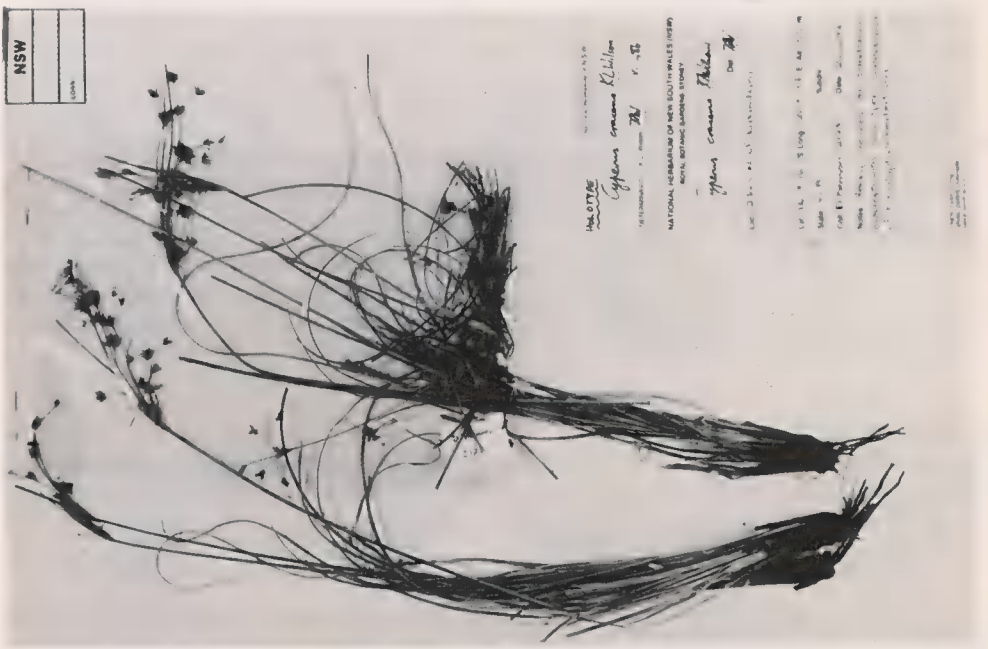
5. Cyperus crispulus *K.L. Wilson*, **sp. nov.**

C. microcephalo affinis sed nuce nitenti superficiebus convexis, foliis crassis canaliculatisque crispatisque, aculeis marginum foliorum mixtis, differt.

Type: Northern Territory: Darwin and Gulf: c. 2 km N of Tanumbirini Waterhole, *K.L. Wilson 5303*, 12 May 1983; holo NSW; iso DNA, K, PERTH. Figure 16a.

Slender perennial, tufted, 20–40 cm high, often viscid. *Culms* terete, smooth, c. 1 mm diam. *Leaves* thickened, canaliculate, usually curly towards the apex, not septate-nodulose, ≤ culms, to 1.2 mm wide, mid-green; midrib not obvious abaxially; marginal prickles sparse to very sparse, regularly spaced (0.2–2.0 mm apart), very short to short,

a



b

Figure 16. Holotype of **a**, *C. crispulus*; **b**, *C. cracens*.

no more than 0.05 mm long, antrorse to erect, aculeate to papillate; leaf sheaths not septate-nodulose, somewhat smooth and shining, pale orange-brown to red-brown. *Inflorescence* small-compound to decompound, 5–12 primary branches to 8 cm long; bracts erect, somewhat curly, 1–2 exceeding the inflorescence. *Spikelets* 3–8 in loose, subdigitate, hemispherical clusters of 0.7–2 cm diam.; spikelets somewhat compressed, oblong, 4–9(–16) mm long, 1.0–1.7 mm wide in side view, 4–12(–18)-flowered, may be viscid; rachilla mostly thickened at maturity (0.05–0.20 mm thick), narrowly to broadly winged, wings 0.05–0.10 mm wide; glume spacing 1.1–1.6(-2.0) mm; spikelet with rachilla persistent and glumes falling individually, or units of ultimate branch plus spikelets falling. *Glumes* elliptic to obovate, acute, with straight mucro 0.1–0.2 mm long, golden-brown to dark red-brown, with green midrib, 1.2–1.7(–2.0) mm long, 0.4–0.6 mm wide, sides 3–5-nerved, margins very narrow-membranous towards apex and ± not inrolled. *Anthers* 0.5–0.8 mm long excluding appendage 0.1–0.3 mm long. *Nut* trigonous, narrow-obovate to narrow-elliptic with broad-acute apex, faces convex, very dark red-brown to black, tuberculate, shining, 1.2–1.7 mm long, about as long as the glume, 0.3–0.5 mm diam., falling separately from glume. Figure 13j–l.

Distribution: From the Northern Kimberley of Western Australia to the Darwin & Gulf region of the Northern Territory. Figure 14d.

Habitat: In crevices on rocky outcrops.

The epithet is the diminutive of the Latin *crispus*, curled, referring to the rather curly leaves and bracts.

C. crispulus is related to *C. sexflorus* and *C. microcephalus* but differs from both species in its low stature, its slender but thickened and curly canaliculate leaves and bracts without an obvious midrib, and with mixed sparse marginal prickles. It is also distinguished from *C. microcephalus* by its smooth culms, and its shining nut with convex faces.

Specimens examined: Northern Territory: Darwin and Gulf: O.T. Station, *Blake 17673*, May 1947 (BRI, K, NSW); 1 km S of Twin Falls, Site 53, *Craven 5806*, May 1980 (CANB); 13 km SSW of Twin Falls, Site 60, *Craven 5903*, May 1980 (CANB); c. 65 km S of Jabiru, Site 29, *Craven & Whitbread 7895*, Mar 1981 (CANB); Deaf Adder Gorge, *Dunlop 4441*, Feb 1977 (DNA, NSW, NT); Tanumbirini Waterhole, *Latz 1406*, June 1971 (NSW ex NT); c. 40 km SSW of Nathan River Homestead, *Latz 10119*, Aug 1985 (NSW ex NT); 150 km W of Borroloola, *Rankin 1878*, Apr 1979 (CANB); Nabarlek area, *Rankin 2062*, Apr 1979 (CANB); c. 2 km N of Tanumbirini Waterhole, *Wilson 5303*, May 1984 (NSW). Western Australia: Gardner: Gibb R.–Kalumburu Mission road, Rocky Creek, *Beauglehole 51849*, May 1976 (NT); 2 km N of Kalumburu, *Benson 2124*, July 1984 (NSW, K, PERTH); West Bay, Napier Broome Bay, *Chesterfield 269*, May 1984 (NSW ex MEL); Mitchell R., *Dunlop 5240*, Feb 1980 (NSW); Camp Creek Gauging Station, Mitchell Plateau, *Keighery 4752*, Apr 1982 (PERTH).

6. Cyperus sexflorus *R. Br.*
Brown (1810: 215); Poiret (1817: 187); Sprengel (1824: 227); Kunth (1837: 111); Steudel (1854: 53); Domin (1915: 432), p.p.; Kern (1974: 661). *C. sporobolus* R. Br. var. *sexflorus* (R. Br.) Benth. ex Kükenthal (1935-36: 457), p.p.

Type: Carpentaria, *R. Brown (Bennett 5903)*; lecto BM (here designated); isolecto BRI (fragm.), K.

Slender perennial, tufted with slender bulbous base, 55–75 cm high, not viscid. *Culms* terete to trigonous, smooth (rarely scabrous at very apex), 1–2 mm diam. *Leaves* flat to canaliculate, not septate-nodulose, usually shorter than the culms, to 3.7 mm wide, mid-green to dark yellow-green; midrib usually obvious abaxially, smooth; marginal

prickles sparse to dense, regularly spaced (0.1–0.6 mm apart), short, 0.05–0.10 mm long, antrorse, aculeate; leaf sheaths septate-nodulose, smooth and ± shining, chestnut-brown to pale red-brown. *Inflorescence* compound, relatively slender, 5–12 primary branches to 7.5 cm long; bracts ± erect, 0–2 exceeding the inflorescence. *Spikelets* few, 3–14 in loose, shortly spicate to subdigitate, hemispherical clusters of (0.5–)0.7–3 cm diam.; spikelets compressed, ± oblong, 4–9(–18) mm long, 1.5–2.5 mm wide in side view, 4–8(–18)-flowered; rachilla not or occasionally slightly thickened (to 0.15 mm thick), narrowly or rarely broadly winged, wings 0.05–0.10 mm wide; glume spacing 1.2–1.5(–1.7) mm; spikelet with rachilla persistent and glumes falling individually, or units of ultimate branch plus spikelets falling. *Glumes* ovate to elliptic, acute to obtuse, with straight mucro 0.1–0.2 mm long, stramineous to golden-brown with occasional red-brown blotches, with green midrib, 1.6–2.1 mm long, 0.6–0.7 mm wide, sides 3–5-nerved, margins narrow-membranous and not inrolled. *Anthers* 0.4–0.8 mm long excluding appendage 0.2–0.5 mm long. *Nut* trigonous, narrow-obovate to narrow-elliptic with broad-acute apex, faces concave to flat, pale brown to nearly black, colliculate to foveate, shining, 1.8–2.1 mm long, ≥ glume, 0.5–0.7 mm diam., falling separately from glume. Figure 13m–o.

Distribution: From the north-eastern Kimberley of Western Australia to the western end of the Burke District of Queensland. Figure 14e.

Habitat: Sandy soils; generally in open woodland below rocky outcrops or occasionally on hillsides.

One of only three species in section *Pinnati* with markedly bulbous culm-bases. It differs from *C. sporobolus* and *C. orgadophilus* (which have similarly bulbous bases and occur in similar habitats) in its bigger, compound inflorescence with few spikelets per cluster, its regularly antrorsely aculeate leaf margins, its glumes which are straight or excurved along the midrib as seen in outline (more or less incurved in *C. sporobolus* and *C. orgadophilus*), and its nut, which generally slightly exceeds the glume.

Specimens examined: Queensland: Burke: Adels Grove, via Camooweal, *De Lestang 338*, Mar 1947 (BRI); near junction of Lawn Hill Creek and Colless Creek, *Taylor 270*, Aug 1981 (BRI). Northern Territory: Darwin and Gulf: about E of Mataranka, on Elsey Station, *Blake 17534* Apr 1947 (BRI, CANB, K, NSW); McArthur R. area, near Caranbirini Waterhole, *Craven 3405*, Jan 1976 (CANB); c. 65 km S of Jabiru, Site 29, *Craven & Whitbread 7894*, Mar 1981 (CANB); Cox R. Station, *Latz 7859*, June 1977 (NT, NSW); Edith Falls, *Wilson 4963*, Apr 1983 (NSW, DNA); c. 2 km N of Tanumbirini Waterhole, *Wilson 5304*, May 1983 (NSW, AD, BRI, DNA); Caranbirini Waterhole, c. 32 km SW of Borroloola, *Wilson 5340, 5341*, May 1983 (NSW, DNA); 25 km WSW of Borroloola on Cape Crawford road, *Wilson 5377*, May 1983 (NSW, BRI, DNA). Victoria River: Keep River National Park, *Dunlop 5731*, Feb 1981 (DNA, NSW); 12 miles [19 km] SSE of Willeroo Station, *Perry 2045*, June 1949 (CANB, BRI, K, NT). Western Australia: Gardner: Kimberley Research Station, *Langfield 31*, Jan 1949 (CANB, PERTH); Anjo Peninsula separating Napier Broome Bay and Vansittart Bay, *Willis*, May 1984 (NSW ex MEL); Hidden Valley, 2.5 km NNE of Kununurra, *Wilson 4794*, Apr 1983 (NSW, AD, DNA, K, PERTH).

7. Cyperus portae-tartari *K.L. Wilson*
Wilson (1980: 460, pl. 26)

Type: Queensland: Burke: Hells Gate, *S.W.L. Jacobs 1527*, 9 May 1974; holo NSW; iso K.

Short but robust annual or perennial with relatively large inflorescence, tufted, shallow-rooted, 35–60(–90) cm high, not viscid. *Culms* trigonous, often scabrous for most of length, 1.2–4 mm diam. *Leaves* flat to carinate, septate-nodulose, ≥ culms, to 8.5 mm wide, dark yellow-green; midrib obvious abaxially, scabrous; marginal prickles dense to occasionally sparse, mostly regularly spaced (0.1–0.6(-0.9) mm apart), short, 0.05–

0.10 mm long, finely antrorse, aculeate; leaf sheaths usually not septate-nodulose, finely striate and slightly shining, pinkish to chestnut-brown or stramineous with dark red-brown blotches. *Inflorescence* compound to decompound (to four orders of branching), numerous primary branches (13->17) to 16 cm long; bracts spreading, 3–8 exceeding the inflorescence. *Spikelets* 1–7 in subdigitate, loose hemispherical to globose clusters of 0.5–1.3 cm diam.; spikelets compressed, oblong, 3–8 mm long, 1.7–2.5 mm wide in side view, 3–10(–20)-flowered; rachilla not thickened, broadly winged, wings 0.10–0.15 mm wide; glume spacing 1.0–1.3(–1.5) mm; glumes falling individually or spikelet falling as a unit, or ultimate branch plus spikelets falling as a unit. *Glumes* broad-elliptic to broad-ovate, broad-acute with relatively stout, straight or excurved mucro 0.2–0.3(–0.5) mm long, red-brown with green midrib (often antrorsely aculeate), 1.3–1.9 mm long, 0.5–0.7 mm wide, sides 2–4-nerved, margins narrow-membranous towards the apex and not inrolled. *Anthers* 0.3–0.8 mm long excluding appendage 0.2–0.3 mm long. *Nut* ± trigonous, obovate to broad-obovate, with broad-acute apex, faces somewhat concave or flat, black, tuberculate, glistening, 1.1–1.4 mm long, ⅞ as long as to exceeding the body of the glume, 0.5–0.7 mm diam., falling separately from the glume. Figure 17a–c.

Figure 17. Spikelet details. *C. portae-tartari*: **a**, spikelet; **b**, glume; **c**, nut. *C. cracens*: **d**, spikelet; **e**, glume; **f**, nut. *C. sporobolus*: **g**, spikelet; **h**, glume; **i**, nut. *C. orgadophilus*: **j**, spikelet; **k**, glume; **l**, nut. *C. blakeanus*: **m**, spikelet; **n**, glume; **o**, nut. **a-c** from *Dunlop 4455*; **d-f** *Beauglehole 51856*; **g-i** *Wilson 5204*; **j-l** *Adams 1400*; **m-o** *Maconochie 781*. a, d, g, j, m X 11; b, c, e, f, h, i, k, l, n, o X 14.

DISTRIBUTION: In the Darwin & Gulf region of the Northern Territory and Burke region of north-western Queensland. Figure 14f.

HABITAT: Sandy soils; damp sites amongst boulders or along streams.

Distinctive in this group by the often scabrous midrib of the glume (occasionally scabrous in *C. cracens*, and rarely so in a few others), but similar in this character to species in the American section *Glutinosi* (*C. elegans*, *C. rubiginosus*, *C. trachysanthos*). This character state is also seen in *C. renschii* Boeck. and *C. laxus* Poir.

The species is similar in habit to *C. microcephalus* but glume and nut shape are very different. Its leaves are the same shade of green as those of *C. astartodes*, with which it sometimes grows. The specimen *Craven 5854* is unusual in having thickened rachillas.

It superficially resembles *C. laxus* Poir. (*C. diffusus* Vahl) in habit and glumes, but the two species are taxonomically distant: *C. laxus*, also found in northern Australia, is a non-Kranz (C_3 photosynthesis) species with soft-textured leaves with distant nerves and nearly smooth margins, smooth triquetrous culms and a broad yellow-brown wing to the rachilla.

SELECTED SPECIMENS (29 examined): QUEENSLAND: Burke: *Jacobs 1527* (K, NSW). NORTHERN TERRITORY: Darwin and Gulf: McArthur R. area, near Glyde R., *Craven 3499*, Jan 1976 (CANB, BRI, L, NT); 9.5 km S of Twin Falls, *Craven 5884*, May 1980 (CANB); Mt Brockman, Site 122, *Craven 6506*, June 1980 (CANB, BRI, DNA, G, NSW); Katherine Gorge National Park, above Lily Pond, *Craven 6715*, Apr 1981 (CANB, DNA); 17.5 km SSE of Koongarra, *Craven 6265, 6274*, June 1980 (CANB); Little Nourlangie Rock, *Dunlop 4727*, Mar 1978 (DNA, CANB), *Wilson 5190*, May 1983 (NSW); Magela Creek, *Dunlop 3366*, Feb 1973 (DNA, BRI, CANB, K, NSW, PERTH); Deaf Adder Gorge, *Dunlop 4455*, Feb 1977 (DNA, NSW, NT); top of Jim Jim Falls, *Dunlop 5650*, Jan 1980 (DNA, BRI, NSW); 6 km S Mt Gilruth, Arnhem Land, *Jones 1548*, Mar 1984 (DNA, BRI, NSW, PERTH); 70 miles [113 km] E of Oenpelli mission, *Latz 3064*, June 1972 (NSW); c. 40 km SSW of Nathan River Homestead, *Latz 10122*, Aug 1985 (NSW ex NT); Radon Creek, c. 12 km S Jabiru, *Latz 7682*, June 1978 (NSW ex NT); Nabarlek area, *Rankin 2057*, Apr 1979 (NT, CANB); Kakadu National Park, c. 5 km S of Cahills Crossing, *Thompson 304*, Apr 1983 (CANB); Edith Falls, *Wilson 4966*, Apr 1983 (NSW).

8. Cyperus cracens *K.L. Wilson*, **sp. nov.**

A *C. sporobolo* habitu inflorescentiaque pergracili, basibus non bulbosis, nuce glumisque saepe latioribus, differt.

TYPE: WESTERN AUSTRALIA: North Kimberley: 2 km N of Kalumburu, *D.H. Benson 2123*, 26 July 1984; holo NSW; iso PERTH. Figure 16b.

[*Cyperus sporobolus* auct. non R. Br.: Fitzgerald (1918: 117), p.p. (*Fitzgerald 1025*, Isdell River)]

Slender perennial, tufted, 35–80 cm high, with spikelets occasionally viscid. *Culms* trigonous to terete, smooth or scabrous, 0.7–1.5 mm diam. *Leaves* canaliculate, usually not septate-nodulose, c. ⅔ as long as culms, to 2.5 mm wide; midrib not obvious abaxially; marginal prickles sparse, regularly spaced (0.4–1.6 mm apart), short, 0.05–0.10 mm long, antrorse, aculeate; leaf sheaths not septate-nodulose, ± smooth and shining, stramineous above, red-brown to purple-red below. *Inflorescence* small-compound to compound, slender, 5–11 primary branches to 10 cm long; bracts erect, 1–2 exceeding the inflorescence. *Spikelets* 4–9 in small, dense, subdigitate, hemispherical to subglobose clusters of 0.3–1 cm diam.; spikelets compressed, oblong, 3–6 mm long, 1.5–3 mm wide in side view, 1–5-flowered, occasionally viscid; rachilla not thickened, broadly winged, wings 0.15–0.25 mm wide; glume spacing (1.3–)1.5–1.8 mm; spikelet with

rachilla persistent and glumes falling individually, or ultimate branch plus spikelets falling as a unit. *Glumes* broad-elliptic to broad-ovate, broad-acute, with excurved mucro 0.2–0.6 mm long, stramineous to occasionally dark red-brown, with green and sometimes scabrous midrib, convex in outline, (1.4–)1.9–2.8 mm long, 0.8–1.1 mm wide, sides (2–)3–5-nerved, margins broad white- to yellow-membranous (reddish in *Dunlop 5269*) and not inrolled. *Anthers* 0.7–1.1 mm long excluding appendage 0.1–0.5 mm long. *Nut* trigonous, obovate to broad-obovate with apex broad-acute, faces concave, black, tuberculate to colliculate, glistening or shining, 1.2–1.9 mm long, ≥ body of glume, 0.8–1.3 mm diam., falling separately from glume. Figure 17d–f.

Distribution: Northern Kimberley region of Western Australia and Darwin & Gulf region in the Northern Territory. Figure 18a.

Habitat: Sandy soils; along creeks on levees or occasionally in rock crevices in dry creek beds.

The epithet refers to the species' slender habit; from the Latin *cracens*, slender or graceful.

Dunlop 5269 differs from other specimens in being very slender, with glumes that are red and short (but still very broad: c. 1.4 mm long, 0.8–0.9 mm wide) and have a short mucro 0.1–0.2 mm long.

C. cracens has been found growing near *C. astartodes*, but is readily distinguished from that species by its broad glumes and nuts and its slender, somewhat weeping habit. *C. cracens* differs from *C. sporobolus* and *C. orgadophilus* in its very slender, tufted habit, its slender inflorescence (which is small-compound and is subtended by 1–2 erect bracts), its broader glumes and nut, and often longer glume mucro. *C. portae-tartari* differs from *C. cracens* in its larger, more branched inflorescence, densely and finely aculeate leaf and bract margins, and smaller nut and glumes (which are less strongly incurved than in *C. cracens*).

Specimens examined: Northern Territory: Darwin and Gulf: Jim Jim Creek, 3.5 km ESE of Jim Jim Falls, Site 55, *Craven 5826*, May 1980 (CANB, DNA, MEL, NSW); 16 km SE of Koongarra (Site 90), *Craven 6254*, June 1980 (DNA, L); 17.5 km SE of Koongarra, Site 92, *Craven 6263*, June 1980 (CANB). Western Australia: Gardner: Kimberleys, Gibb R.–Kalumburu Mission road, Rocky Creek, *Beauglehole 51856*, May 1976 (NT); Rocky Creek, c. 60 km N of Drysdale River, *Benson 2088b*, July 1984 (NSW); Anjo Peninsula, *Chesterfield 406*, May 1984 (NSW ex MEL); Mitchell R., *Dunlop 5269*, Feb 1980 (NSW); Isdell R., near Mt Barnett HS., *Fitzgerald 1025*, May 1905 (PERTH, BRI); Blyxa Creek, Prince Regent R. Reserve, *George 12515*, Aug 1974 (PERTH). Fitzgerald: Augustus I., Bonaparte Archipelago, *P. Wilson*, May 1972 (PERTH).

9. Cyperus sporobolus *R. Br.*
Brown (1810: 215); Poiret (1817: 187), as 'spherobolos'; Sprengel (1824: 226); Kunth (1837: 111); Steudel (1854: 53); Bentham (1878: 281) p.p.; Bailey (1902: 1746) p.p.; Domin (1915: 432); Ewart & Davies (1917: 56) p.p.; Kükenthal (1935-36: 457) p.p.

Type: Northern Territory: Carpentaria island 's' [Morgans Island, Blue Mud Bay], *R. Brown (Bennett 5904)*; lecto BM (here designated); isolecto BM, BRI (fragm.), DBN, E, K. There is a second sheet labelled *Bennett 5904* in K but with the locality given as 'East Coast'. This is a mixture of *C. fulvus* (left-hand specimen) and *C. sporobolus* (right-hand specimen).

Slender perennial, with definitely bulbous base, tufted or very shortly rhizomatous, 30–80 cm high, not viscid. *Culms* obscurely trigonous to terete, smooth, 1–2 mm diam. *Leaves* occasionally somewhat thickened, canaliculate, flat or carinate, occasionally septate-nodulose, from half as long as to longer than culms, to 2.5(–5) mm wide, yellow-

green to mid-green; midrib often obvious abaxially, usually smooth; marginal prickles very sparse to dense, usually regularly spaced (0.2–1.1 mm apart), short, 0.05 mm long, antrorse to erect, aculeate; leaf sheaths not septate-nodulose, not shining, orange-brown. *Inflorescence* simple or small-compound, 3–8 primary branches to 7 cm long; bracts erect or spreading, may be somewhat curly, 2–5 exceeding the inflorescence; small leafy bracts obvious at the base of individual spikelet clusters. *Spikelets* numerous in dense,

Figure 18. Distribution of: **a**, *C. cracens*; **b**, *C. sporobolus*; **c**, *C. orgadophilus*; **d**, *C. blakeanus* (crosses) and *C. angustatus* (open circles; New Guinea occurrence not mapped); **e**, *C. ixiocarpus* (crosses) and *C. viscidulus* (open circles); **f**, *C. carinatus* (crosses) and possible hybrid *C. carinatus* X *C. centralis* (open circles).

subdigitate, hemispherical or ovoid clusters of 0.5–1.5 cm diam.; spikelets ± compressed, shortly oblong, 3–6(–15) mm long, 1.5–3.0 mm wide in side view, 2–5(–14)-flowered; rachilla mostly thickened (to 0.25 mm thick), broadly winged, wings 0.1–0.2 mm wide; glume spacing 1.5–2.1 mm; spikelets with rachilla persistent and glumes falling individually. *Glumes* broad-ovate to ovate, acute, with incurved to excurved mucro 0.2–0.5 mm long, golden-brown to pale red-brown, with green midrib strongly incurved or straight in outline, 2.0–2.6 mm long, 0.6–1.0 mm wide, sides 3–5-nerved, margins usually very narrow-membranous and not inrolled. *Anthers* 0.5–1.0 mm long excluding appendage 0.2–0.3 mm long. *Nut* trigonous, obovate to narrow-elliptic with broad-acute to acute apex, faces concave or flat, very dark red-brown to black, tuberculate, glistening or shining, 1.7–2.3 mm long, as long as to slightly exceeding glume, 0.5–1.0 mm diam., falling separately from glume. Figure 17g–i.

DISTRIBUTION: Only in the Darwin & Gulf region of the Northern Territory. Figure 18b.

HABITAT: Sandy or lateritic soils; in open savanna woodland, usually associated with rock outcrops, or in soil pockets on rocky hillsides.

This species, *C. orgadophilus* and *C. sexflorus* (q.v.) are the only three species in this Section with strongly bulbous bases. Occasionally, *C. blakeanus*, *C. centralis* and *C. fulvus* have somewhat bulbous bases.

C. sporobolus is close to *C. orgadophilus* but differs in its thickened and broadly winged rachilla, its greater glume spacing, its glumes (differently shaped, more prominently nerved, and with a longer mucro), its nut (colour, shape and size), and its ± regularly aculeate leaf margins. In addition, the inflorescence of *C. sporobolus* has a different appearance because of the prominence of the short leaf-like bracts at the base of each spikelet cluster. Spikelets are generally short but occasionally are much longer (e.g. *Dunlop 3046*, which has a mixture of long and short spikelets). The two species have slightly overlapping distributions in the Top End of the Northern Territory, but they have not been found growing together at any site. Indeed, their habitat preferences seem different. *C. sporobolus* is associated with rocky outcrops in woodland, while *C. orgadophilus* grows in savanna woodland too, but associated with low-lying areas rather than rocky outcrops.

Ryves (1976) lists *C. sporobolus* as a wool-alien at Blackmoor Fruit Farm, N Hants., England, but the specimen (n.v.) is unlikely to be this tropical species. It may be *C. fulvus* or *C. rigidellus*: both are species that are found in wool-producing areas.

SELECTED SPECIMENS (25 examined): NORTHERN TERRITORY: Darwin and Gulf: 16 km SE of Koongarra, Site 90, *Craven 6254*, June 1980 (CANB, BRI, MEL, NSW); near Bills Pool, *Blake 17018*, Sep 1946 (BRI); 26 km S of Cooinda, Site 106, *Craven 6370*, June 1980 (CANB); Katherine Gorge National Park, above Lily Pond, *Craven 6722*, Apr 1981 (CANB, DNA, L); c. 4 km E of Jabiru, Site 20, *Craven & Whitbread 7880*, Mar 1981 (CANB, DNA); c. 40 km NW of Jabiru, Site 15, *Craven & Whitbread 7897*, Mar 1981 (CANB); Gunn Point, Darwin, *Dunlop 3046*, May 1973 (DNA, BRI, NT), *McKean 1330*, Dec 1973 (NT, BRI, CANB, K, L, NSW); Hayes Creek, *Dunlop 4096*, Jan 1976 (DNA, BRI, CANB, NSW, NT); Twin Falls, *Dunlop & Taylor 6222*, Mar 1982 (DNA, CANB, NSW, NT); Arnhem Land, *Latz 2955*, June 1972 (DNA, BRI, CANB, NT); Elcho Island, *Latz 6130*, July 1975 (DNA, BRI, NT); Lake Bennett road, 2 km E of Stuart Highway, *Wilson 5047*, Apr 1983 (NSW); Moline Rockhole, 9 km NE of Mary R., *Wilson 5204*, May 1983 (NSW); Christmas Creek rock paintings, *Wilson 5238*, May 1983 (NSW); 0.5 miles [1 km] NW of Edith R. siding, *I. Wilson 218*, Jan 1965 (CANB, BRI, NT).

10. Cyperus orgadophilus *K.L. Wilson*, **sp. nov.**

A *C. sporobolo* rhachilla nec alata nec crassa, intervallo inter glumas adjacenti 0.7–1.5 mm, glumis ellipticis mucrone breviore, nuce pallidiore, aculeis marginum foliorum mixtis, differt.

Type: Northern Territory: Victoria River: 15 km S of Victoria Highway on Delamere road, *K. Wilson 4924 & R. Barker*, 27 Apr 1983; holo NSW; iso BRI, DNA, K, P. Figure 19a.

[*Cyperus angustatus* var.: Boeckeler (1874: 367); *Schultz 291* is cited but presumably this is an error for *Schultz 791* (K)]

[*Cyperus carinatus* auct. non R. Br.: Kükenthal (1935–36: 455), p.p. *Mariscus carinatus* auct. non (R. Br.) C.B. Clarke: Domin (1915: 441), p.p. (*Henne*, Sweers Island)]

[*C. fulvus* auct. non R. Br.: Domin (1915: 443), p.p. min.; Kükenthal (1935–36: 456), p.p. min. (*MacGillivray*, Cape York)]

[*C. holoschoenus* auct. non R. Br.: Bentham (1878: 273), p.p. min.; Kükenthal (1935–36: 481), p.p. min. *Mariscus holoschoenus* auct. non (R. Br.) C.B. Clarke: Domin (1915: 441), p.p. min. (*Mueller*, Upper Victoria River)]

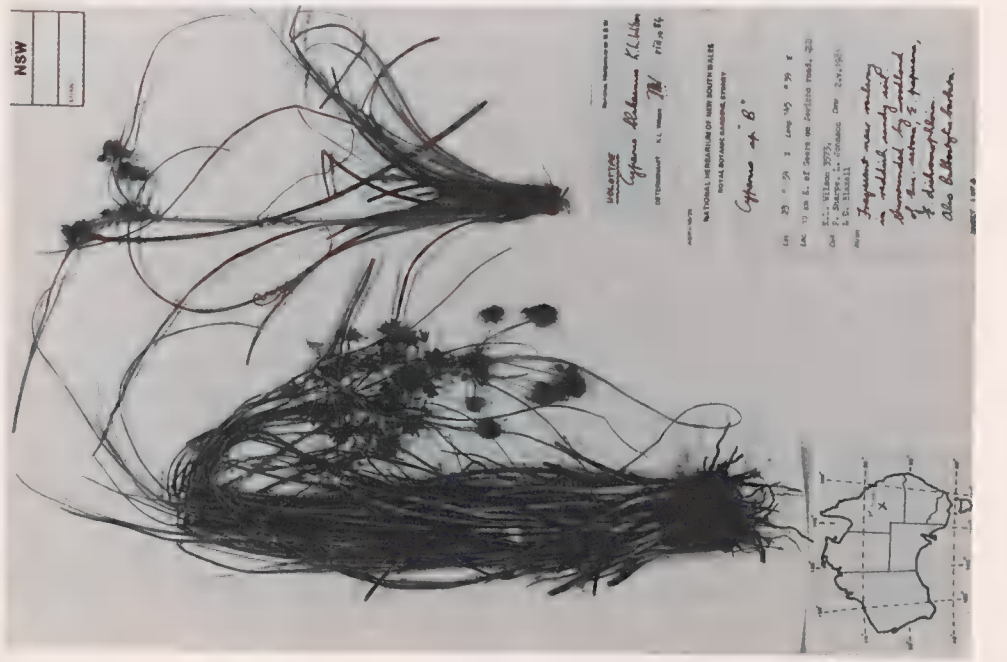
[*C. sexflorus* auct. non R. Br.: Domin (1915: 432), p.p. (*Schultz 791*, Port Darwin)]

[*C. sporobolus* auct. non R. Br.: Bentham (1878: 281) p.p.; Bailey (1902: 1746) p.p.; Ewart & Davies (1917: 56) p.p.; Kükenthal (1935–36: 457) p.p.; Blake in Specht & Mountford (1958: 319)]

Slender perennial, with definitely bulbous base, tufted or very shortly rhizomatous, 30–80 cm high, not viscid. *Culms* obscurely trigonous to terete, smooth, 1–2 mm diam. *Leaves* canaliculate, mostly septate-nodulose, from half as long as to longer than culms, to 2.5(–5) mm wide, yellow-green to mid-green; midrib not obvious abaxially; marginal prickles very sparse to dense, irregularly spaced (0.2–3.0 mm apart), short, 0.05–0.10 mm long, antrorse to retrorse or flabellate, papillate or aculeate; leaf sheaths not septate-nodulose, not shining, orange-brown. *Inflorescence* simple or small-compound, 3–8 primary branches to 7 cm long; bracts erect or spreading, may be somewhat curly, (1–)2–4 exceeding the inflorescence. *Spikelets* numerous in dense, subdigitate, hemispherical or ovoid clusters of 0.5–1.5 cm diam.; spikelets ± compressed, shortly oblong, 3–6.5 mm long, 1.5–2.5 mm wide in side view, (1–)3–8-flowered; rachilla not thickened, mostly narrowly winged, wings 0.05–0.10 mm wide; glume spacing 0.7–1.5 mm; spikelets with rachilla persistent and glumes falling individually. *Glumes* elliptic, occasionally narrower, acute to broad-acute, with straight or incurved mucro <0.1–0.2 mm long, stramineous to pale red-brown, with green midrib usually incurved in outline, 1.5–2.5 mm long, 0.3–0.8 mm wide, sides 3–5-nerved, margins usually very narrow-membranous and not inrolled. *Anthers* 0.5–1.0 mm long excluding appendage <0.1–0.2 mm long. *Nut* trigonous, narrow-elliptic to narrow-obovate with acute apex, faces flat, yellow-brown to pale red-brown, tuberculate or small-colliculate, shining, 1.5–2.2 mm long, slightly shorter than to equalling glume, 0.5–0.7 mm diam., falling separately from glume. Figure 17j–l.

Distribution: From the far eastern Kimberley of Western Australia to Cook District, Queensland. The species seems not to extend to the northern part of the Top End of the Northern Territory (the northernmost known localities are near Pine Creek and an apparent outlier near Jim Jim Creek). An old specimen labelled Port Darwin (*Schultz 791*; K) is probably mislabelled. Figure 18c.

a



b

Figure 19. Holotype of **a**, *C. orgadophilus*; **b**, *C. blakeanus*.

HABITAT: Sandy or lateritic soils; in open savanna woodland, often in more low-lying places.

The epithet is derived from Greek *orgas, orgados*, a partly wooded field or a well-watered, fertile tract of land, and *phileo*, to love, referring to the savanna habitat of the subspecies.

Specimens from the eastern end of the subspecies' range have larger glumes than those from the western part of its range (NW Queensland to the Kimberley): glumes 2.0–2.6 mm long, 0.5–0.8 mm wide in side view *versus* 1.5–2.0 mm long, 0.3–0.6 mm wide. There do not seem to be any other significant differences.

The species is close to *C. sporobolus* (q.v.), which also has a strongly bulbous base. It differs from that species in its thin rachilla (usually with narrow wings), its lesser glume spacing, its elliptic glumes with shorter mucro, its paler nut, and its irregularly papillate or aculeate leaf margins.

SELECTED SPECIMENS (37 examined): QUEENSLAND: Cook: near Mareeba, *Blake 13425*, Mar 1938 (BRI, K, MEL, NSW); near Cooktown, Endeavour R., *Blake 20253*, Feb 1958 (BRI); 6 km from Watson R. Crossing on Aurukun–Merluna road, *Clarkson 4068*, Dec 1981 (CANB, NSW ex BRI); Lizard Island, *Specht & Specht LI 273, 275*, Dec 1974 (BRI); Kalinga Station (Hann Telegraph Office), *Staples IBS 2245*, Jan 1976 (NSW). Burke: 60 km SE of Normanton and 8 km N of Croydon road, *Beeston 92*, June 1972 (BRI, NT); Normanton, *Blake 8955*, May 1935 (BRI); Sweers Island, *Henne*, – (BRI 177987, K, MEL). NORTHERN TERRITORY: Darwin and Gulf: N of Nutwood Downs HS. on lateritic tableland, *Blake 17581*, May 1947 (BRI); c. 50 km SSW of Jabiru, Site 3, *Craven & Whitbread 7901*, Mar 1981 (CANB); Pine Creek, *Dunlop 4176*, Apr 1977 (DNA, NSW); Arnold River shed, *Latz 7144*, June 1977 (NSW); King R., 25 miles [40 km] S of Katherine, *McKee 8453*, Feb 1961 (BRI, K, NSW, NT); c. 2 km N of Tanumbirini Waterhole, *Wilson 5305*, May 1983 (NSW); 25 km WSW of Borroloola on Cape Crawford road, *Wilson 5380*, May 1983 (NSW). Victoria River: Victoria R., Gregory National Park, *Clark & Wightman 365*, Feb 1986 (DNA). Western Australia: Gardner: Anjo Peninsula, E of Vansittart Bay, *Willis*, May 1984 (NSW ex MEL). Fitzgerald: c. 17.5 km S of Turkey Creek, Winnama Spring, *Willis*, May 1984 (NSW ex MEL). Hall: Mabel Downs, Winnama Gorge, Turkey Creek, *Chesterfield 208*, May 1984 (NSW).

11. Cyperus blakeanus *K.L. Wilson*, **sp. nov.**

C. sporobolo affinis sed basibus non nisi subbulbosis, antheris longioribus, glumis anguste ovatis apice longe acuto, differt.

TYPE: QUEENSLAND: Mitchell: 17 km E of Geera on Jericho road, *K.L. Wilson 3573, P. Sharpe, L. Johnson and D. Blaxell*, 2 May 1981; holo NSW; iso BRI, K, NT. Figure 19b.

[C. sp. aff. *holoschoenus*: Wilson (1981a: 508, Figure 638J)]

More or less slender perennial, tufted, often with a thickened and somewhat bulbous base, 25–55 cm high, not viscid. *Culms* trigonous with very rounded angles or terete in big specimens, smooth or slightly scabrous, 1.0–3 mm diam. *Leaves* somewhat thickened, canaliculate, occasionally septate-nodulose, ⅔ as long as to slightly exceeding culms, to 3 mm wide; midrib rarely obvious abaxially and may then be scabrous; leaf margins sparse to very sparse, irregularly spaced (0.1–2.0 mm apart), short, c. 0.05 mm long, erect to antrorse or flabellate, papillate to aculeate; leaf sheaths not septate-nodulose, smooth, occasionally shining, salmon-pink to pale brown with brown-hyaline margins. *Inflorescence* simple to small-compound, dense or ± open; primary branches 5–9(–11), to 6.5 cm long, occasionally reflexed; bracts erect or spreading, 2–5(–7) exceeding the inflorescence. *Spikelets* numerous in shortly spicate to subdigitate, hemispherical or ovoid clusters of 0.5–1.5 cm diam. (occasionally the clusters coalesce to give a head-like appearance to the inflorescence). Spikelets compressed when young, compressed or sometimes spirodistichous (and then terete)

when mature, oblong to ovate, 3–5(–9) mm long, 2.0–3.0(–3.5) mm wide in side view, 2–8(–12)-flowered; rachilla rarely thickened at maturity (to 0.1 mm thick), usually narrowly winged, wings 0.05–0.10 mm wide; glume spacing c. 0.6 mm in spirodistichous spikelets, 0.9–1.3(–1.5) mm in distichous spikelets; spikelet with rachilla persistent and glumes falling individually. *Glumes* ovate to elliptic, long-acute with straight mucro ≤0.1(–0.2) mm long, stramineous with red-brown blotches or evenly red-brown (rarely somewhat golden) with broad green midrib, 2.0–3.0 mm long, 0.5–1.0 mm wide, sides 2–4-nerved (nerves usually close to midrib), margins not inrolled but spreading and not membranous or very narrow-membranous. *Anthers* 1.2–2.0 mm long excluding appendage 0.1–0.3 mm long. *Nut* trigonous, narrow-obovate or occasionally shorter and obovate with broad-acute apex, faces concave to flat, golden-brown to dark red-brown to nearly black, smooth and reticulate-areolate, shining, 1.2–2.0 mm long, ½ – ⅞ as long as glume, 0.5–0.8 mm diam., falling separately from glume. Figure 17m–o.

Distribution: From the Pilbara and Dampier regions of Western Australia to Central Australia (Central North and Central South), with isolated occurrences in central and southwestern Queensland (Mitchell and Warrego Districts). Figure 18d. Its distribution parallels that of the grass *Triodia pungens* (Burbidge 1953), except that the latter is also known from the Mt Isa area.

Habitat: Sandy or loam soils, in open woodland or shrubland, commonly with *Triodia pungens*, in run-on areas between stable sand-dunes.

The epithet commemorates Dr Stanley Thatcher Blake (1911–1973) of Brisbane, who contributed so greatly to the taxonomic understanding of Australasian Cyperaceae, including this group.

This species differs from all other arid-zone species in the following combination of characters: short culms often with somewhat bulbous bases, small inflorescence with very dense small clusters of spikelets, and mixed prickles on the leaf margins. Its spikelets are mostly laterally compressed but are sometimes spirodistichous (Snow 1955), apparently due to crowding in the small compact spikelet clusters. Glumes are generally brightly coloured at first but fade considerably with age. One specimen (*Wilson 3573*) has the lowest inflorescence bract and branch separated by about 2 cm from the rest of the inflorescence.

Despite my tentative assignment in the 'Flora of Central Australia', this species is more closely related to *C. sporobolus* and *C. orgadophilus* than to *C. holoschoenus*. It differs from the former two species in its only slightly bulbous bases, longer anthers and narrow-ovate glumes with long-acute apex. From *C. sporobolus* it further differs in the marginal prickles, the narrowly winged rachilla, the lesser glume spacing, generally shorter glume mucro and the lack of obvious involucral bracts at the base of each spikelet cluster. From *C. orgadophilus* it also differs in the often larger glumes.

Domin (1915: 444) mentions a specimen he had collected 'auf den Sandhügeln der Dividing Range östlich von Jericho'. He referred the specimen to *C. fulvus* but it could be *C. blakeanus*. I have not seen the specimen.

Selected specimens (32 examined): Queensland: Mitchell: 55 km E of Aramac on Strasburg road, *Beeston 1276*, July 1975 (BRI); Yalleroi, *Clemens*, Apr 1946 (BRI 198859); c. 14 km E of Geera on Jericho road, *Wilson et al. 3570*, May 1981 (NSW, BRI, K, NT, NY, P, PERTH). Warrego: Gilruth Plains, *Clarke 53*, June 1949 (CANB). Northern Territory: Victoria River: Winnecke Creek, *Latz 3981*, July 1973 (NT, CANB, NSW). Central North: Red Bank Bore, Coniston Station, *Latz 1213*, Jan 1971 (NT, NSW); Kurundi Station, *Latz 2200*, Feb 1972 (NT, AD, BRI, NSW); Macdonald Downs, *Latz 5786*, Oct 1974 (NT, BRI, K, NSW); Napperby Station, *Latz 5931*, May 1975 (NT, NSW, PERTH); c. 9 miles [14 km] NE of Pats Swamp, Mongrel Downs, *Maconochie & Parker 1027*, May 1970 (NT, AD, BRI, NSW, PERTH); between Mt Davidson and Refuge Basin, *Parker 208*, May

1970 (NT, BRI, L, NSW, PERTH). Central South: 0.5 miles [1 km] E of Ewalinga Rockhole, Petermann Range, *Maconochie 781*, Sep 1969 (NT, AD, BRI, NSW, PERTH). Western Australia: Dampier: Willie Creek crossing on Beagle Bay road, *Foulkes 99*, Jan 1985 (PERTH). Mueller: just W of Wolf Creek Crater, *George 15308*, Apr 1979 (PERTH, CANB, NT); 33 miles [53 km] S Sturt HS., *Latz 4034* (NT, NSW). Canning: N of Dragon Tree Soak, Great Sandy Desert, *George 14757*, Aug 1977 (PERTH). Fortescue: between Port Hedland and Mundabullangana Station, *George 3346*, Feb 1962 (PERTH, BRI). Keartland: Little Sandy Desert, *Mitchell 918, 937*, May 1979 (NT). Ashburton: 20 km S of Landor HS., *P. Wilson 8492*, Mar 1969 (PERTH). Carnarvon: Towrana Station, *Cranfield 2108*, – (PERTH).

12. Cyperus angustatus *R. Br.*

Brown (1810: 214); Sprengel (1824: 221); Kunth (1837: 111); Steudel (1854: 53); Boeckeler (1874: 366), as 'angustatis'; F. Mueller (1875: 54); Bentham (1878: 282), p.p.; Bailey (1902: 1746), p.p.; Ewart & Davies (1917: 55); Kükenthal (1936: 452), p.p.; Kern (1963: 27; 1974: 638). *Mariscus angustatus* (R. Br.) C.B. Clarke (1908: 19); Domin (1915: 444), p.p.

Type: Northern Territory: North Coast, *R. Brown (Bennett 5909)*; holo BM.

[*C. fulvus* auct. non R. Br: Mueller (1874: 268), p.p. min. (*Schultz 259*, Port Darwin)]

Slender perennial, rhizomatous, 40–100 cm high, not viscid. *Culms* obscurely trigonous to ± terete, smooth or rarely scabrous near the apex, 0.9–1.7(–3) mm diam. *Leaves* slender, flat, folded to canaliculate with age, not septate-nodulose, about same length as culms, to 3.5 mm wide; midrib not obvious; marginal prickles sparse (may be nearly absent throughout length), irregularly spaced (0.1–0.9 mm apart), short to long, 0.05–0.15 mm long, antrorse, aculeate; leaf sheaths not septate-nodulose, not shining or smooth, stramineous to red-brown at base, margins pale membranous. *Inflorescence* simple or small-compound, very open, 4–11 primary branches to 11(–20) cm long; bracts erect and spreading, 1–2 exceeding inflorescence. *Spikelets* few (3–12) in loose, subdigitate, hemispherical clusters of 1–3.5 cm diam.; spikelets compressed, oblong, 7–28 mm long, 1.5–2.5 mm wide in side view, 6–28-flowered; rachilla not thickened, usually broadly winged, wings 0.1–0.15 mm wide; glume spacing 1.3–1.8 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic to very narrow-ovate, acute with straight mucro 0.1–0.2 mm long, stramineous to red-brown with narrow green midrib, 1.6–2.3 mm long, 0.5 mm wide, sides 2–4-nerved; margins narrow-membranous and not inrolled. *Anthers* 0.3–0.8 mm including appendage ≤0.1 mm long. *Nut* trigonous to nearly terete, narrow-elliptic to narrow-obovate with acute apex, faces flat, pale brown to grey, smooth and reticulate-areolate, shining, 1.5–2.1 mm long, equalling or slightly exceeding the glume, 0.5–0.7 mm diam., falling separately from the glume. Figure 20a–c.

Distribution: Tropical coast and adjoining islands from Darwin, Northern Territory, to the eastern coast of Queensland. Also south-eastern Irian Jaya, in New Guinea. Figure 18d.

Habitat: Alluvial soils; generally seasonally wet sites, often in fringing woodland at edges of floodplains, swamps or lagoons.

C. angustatus is distinctive in this group of species by its slender habit and rhizome. Occasionally it grows larger and produces big inflorescences with primary branches to 20 cm long (e.g. *Lazarides & Adams 274, Wilson 5090*), but then its parts remain slender and the inflorescences are open and delicate in aspect. It has been confused at times with *C. fucosus* (q.v.).

Specimens collected by Birch from Bowen/Barcoo Downs (e.g. *BRI 199601, MEL 92163*) and cited as *C. angustatus* by Bentham, Bailey and Kükenthal, are actually *C. bifax*

C.B. Clarke. Both 'Bowen Downs' and 'Barcoo Downs' appear on labels of specimens with Birch as collector: the two place-names seem to be synonymous. According to Kükenthal, Domin (1915) included specimens of *C. subulatus* (e.g. *Dietrich 625*, Port Mackay (L!)) in his concept of *C. angustatus*.

Figure 20. Spikelet details. *C. angustatus*: **a**, spikelet; **b**, glume; **c**, nut. *C. ixiocarpus*: **d**, spikelet; **e**, glume; **f**, nut. . *C. viscidulus*: **g**, spikelet; **h**, glume; **i**, nut. **a–c** from *Latz 3651*; **d–f** *Chippendale 2078*; **g–i** *Beauglehole 47242*. a, d, g X 11; b, c, e, f, h, i X 14.

SPECIMENS EXAMINED: QUEENSLAND: Cook: Cairns, *Blake 9352*, June 1935 (BRI), *Blake 23261*, May 1970 (BRI, NSW); Lockerbie, 10 miles [16 km] WSW of Somerset, *Brass 18608*, May 1948 (CANB). NORTHERN TERRITORY: Darwin and Gulf: Elcho I., *Latz 6247*, July 1975 (DNA, BRI, NT); Radon Creek, Mt Brockman, *Dunlop 5438*, Apr 1980 (NSW, READING); Darwin, Holmes Jungle, *Latz 3651*, Apr 1973 (NSW); McMinns Lagoon, 17 miles [27 km] ESE of Darwin, *Lazarides & Adams 274*, Mar 1965 (CANB); Ritjirriur Swamp, Elcho I., *Latz 6134*, July 1975 (NT); Wurrpan, Elcho I., *Latz 6218*, July 1975 (NT); Leichhardt Springs, *Rice 2691*, June 1978 (DNA); Port Darwin, *Schultz 259*, Feb 1870 (B, BRI, K, MEL); Mardlow, Melville I., *Stocker 282 & Fox*, Apr 1967 (BRI); Appletree Point, Kapalga, *Taylor 350*, Apr 1981 (BRI), *Taylor 391*, May 1981 (BRI); East Alligator R., c. 4 km N of Cahills Crossing, *Waterhouse 9763*, Apr 1980 (NSW, UNSW); Fogg Dam, *Wilson 5090*, May 1983 (NSW, DNA, H, K, P, PERTH, UB); Little Nourlangie Rock, Kakadu National Park, *Wilson 5189*, May 1983 (NSW, DNA, K, P, PERTH). NEW GUINEA Irian Jaya: Koerik [Kurik], Noordpolder [near Merauke], *Hoogerwerf 192*, Mar 1962 (L, BRI).

13. Cyperus ixiocarpus *F. Muell.*

Mueller (1886: 55), preprint of (1887: 55); Domin (1915: 430); Blake (1947a: 35), p.p. max.; Wilson (1980: 462, pl. 27, figs. a, b); Wilson (1981a: 506, Figure 638C).

TYPE: WESTERN AUSTRALIA: between the Fortescue and Gascoyne Rivers, *H.S. King*, 1885; lecto MEL (Blake 1947a). Blake stated that Mueller only cited one specimen but he did, in fact, cite two: the King collection and a Forrest collection from the Gascoyne River. Blake actually cited the latter as well in his paper but indicated only the former as type. Depending on one's interpretation of the International Code, Blake's publication may be regarded as inadequate for lectotypification; if so, then this present paper should be regarded as the place of lectotypification.

[*C. dactylotes* auct. non Bentham: Ewart & Davies (1917: 55), p.p. (*Hill 318*)]

[*C. fulvus* auct. non R. Br.: Fitzgerald (1918: 117, p.p. (*Polak*, Gascoyne River)]

Robust perennial, tufted, deep-rooted, 50–80 cm high, very viscid in the inflorescence (apparently produced in the spikelets). *Culms* terete, smooth, 2.5–3.5 mm diam. *Leaves* thick-textured, canaliculate, septate-nodulose, ⅔ as long as culms, to 5 mm wide, tending to curve when long, pale blue-green; midrib usually not obvious abaxially, or occasionally obvious and scabrous towards the apex; marginal prickles very sparse to sparse, irregularly spaced (0.6–3.5 mm apart), short, 0.05–0.1 mm long, somewhat antrorse, aculeate; leaf sheaths not septate-nodulose, striate, not shining, stramineous with dark red-brown blotches. *Inflorescence* compound or rarely decompound, 9-18 primary branches to 12 cm long; bracts ± erect, septate-nodulose, tending to curve when long, 2–3 exceeding the inflorescence. *Spikelets* few in loose, subdigitate, hemispherical clusters 1.5–3.5 cm diam.; spikelets compressed, oblong, 10–35 mm long, 3.0–5.0 mm wide in side view, 6–28-flowered, very viscid; rachilla not thickened, not to broadly winged, wings to 0.15 m wide; glume spacing 2.2–2.7 mm; spikelet with rachilla persistent and glumes falling individually, or unit of spikelets plus ultimate branch falling. *Glumes* elliptic to ovate, acute with straight mucro 0.2–0.5 mm long, stramineous to golden-brown with green midrib, 2.5–3.0 mm long, 0.6–0.8 mm wide, sides 2–3-nerved, margins not inrolled and very narrow-membranous. *Anthers* 0.7–1.3 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, broad-obovate to elliptic with broad-acute apex, faces concave, dark brown to black, small-colliculate to tuberculate, shining, usually viscid, 1.6–2.1 mm long, ⅔ – ¾ as long as glume, 1.0–1.1 mm diam., broader than glume but held in place by viscidity and falling with glume. Figure 20d–f.

DISTRIBUTION: From the Pilbara region of Western Australia through Central Australia (Central North and South) to Mt Isa, Queensland. Figure 18e.

HABITAT: Apparently restricted to sandy banks or sand drifts in stream-beds (where moisture is often close to the surface).

This species is distinctive because of its large floral parts and its extremely viscid spikelets. Immature spikelets are not viscid. Blake (1947a) created a new section *Ixiocarpi* (in subgenus *Cyperus*) for this 'attractive and distinctive' species, having dismissed the possibility of a close relationship with *C. elegans* L. He regarded the morphological differences between *C. ixiocarpus* and *C. dactylotes* as being too great for them to be included in the same Section (a point of view with which I disagree). He suggested an affinity with *'C. zollingeri'* (= *C. tenuiculmis* Boeckeler), but then (rightly) gave a long list of morphological characters by which it differs from that species. The leaf anatomy of that species also differs: as seen in cross-section, it has a single row of vascular bundles, not A-type anatomy as in *C. ixiocarpus*.

It can be distinguished from *C. viscidulus*, another species in which the glumes are often viscid, by its stiffer inflorescence branches, greater glume spacing, its larger glumes, anthers and nuts, its narrower glume margins, and the prickles on its leaf margins.

It occasionally grows with *C. betchei* subsp. *commiscens*, *C. dactylotes* and *C. cunninghamii* subsp. *cheradicus*. Its broader nut and spikelets, its strong viscidity, and the irregular prickles on the leaf margins distinguish it from all these taxa. *C. cunninghamii* subsp. *cheradicus* is also occasionally viscid, but differs in being more slender with longer glumes.

A note on one specimen, *Green NT 54058* from 'Utopia' Station, says that the species is used medicinally by the Aborigines but no details are given.

Kükenthal (1935–36) cited a specimen, *'Forrest*, Fortescue River', under *C. dactylotes*. This may belong rather to *C. ixiocarpus*, which species Kükenthal did not even mention.

SELECTED SPECIMENS (41 examined): QUEENSLAND: Burke: Mt Isa, Leichhardt R., *Blake 8755*, Apr 1935 (BRI, K), *Wilson 5481*, May 1983 (NSW, BRI); 12 miles [19 km] S of Mt Isa township, *Perry 774*, May 1948 (CANB, AD, BRI, K, MEL, NSW, NT). NORTHERN TERRITORY: Central North: Crown Creek, 5 miles [8 km] W of Coniston HS., *Chippendale 2078*, May 1956 (NT, BRI, CANB, MEL, NSW); Utopia HS., *Green*, Dec 1977 (NT 54058, NSW); Landers Creek, *Hill 318*, June 1911 (MEL); Waite Creek, 28 km SE of Vaughan Springs, *Latz 8670*, May 1981 (CBG, NSW ex NT); Jinka Station, *Latz 9618*, July 1983 (NSW); Hanson R., c. 1 km WNW of Stuart Monument, *Wilson 4657*, Apr 1983 (NSW). Central South: Hay R. c. 14 km SSE of Mt Winnecke, *Purdie 2338*, July 1982 (CANB, CBG). WESTERN AUSTRALIA: Fortescue: The Pool, Marble Bar, *Beauglehole & Carr 48405*, Aug 1974 (MEL, NSW, NT); Coongan R., Warralong Station, *Burbidge 690*, May 1941 (PERTH); Stoneyard Creek, Muccan Station, *Burbidge 909*, June 1941 (BRI, PERTH); Corong Creek, Woodstock Station S of Port Hedland, *Burbidge 5840*, Apr 1958 (CANB, BRI, PERTH); Yule R. watershed, northernmost crossing of Beabea Creek, by main Wittenoom–Newman road, *Jackson 2962*, Aug 1977 (AD); near old Shay Gap Construction Camp, c. 165 km E of Port Hedland, *Newbey 10266*, July 1984 (PERTH); 14 km N of Abydos siding on Port Hedland road, *Symon 10083*, May 1975 (AD, NSW, NT). Carnarvon: Gascoyne R., at crossing by NW Coastal Highway, *Jackson 3095*, Aug 1977 (AD). Ashburton: Barlee Range, *Robinson*, Sep 1959 (PERTH). Kearland: Rudall R., *George 10663*, May 1971 (PERTH), Aug. 1971 (PERTH).

14. Cyperus viscidulus *K.L. Wilson*
Wilson (1980: 462, pl.27, figs. c–f).

TYPE: WESTERN AUSTRALIA: 15 miles [24 km] N of Bow River Station, Kimberleys, *M. Lazarides 5053*, 15 Apr 1955; holo NSW; iso AD, BRI, CANB, K, NT, P, PERTH.

Cyperus sporobolus R. Br. var. *sexflorus* (R. Br.) Benth. ex Kükenthal (1935–36: 457), p.p. min. (*Mueller*, Oberer Victoria-River).

[*Cyperus carinatus* auct. non R. Br.: Bentham (1878: 274), p.p. min.; Ewart & Davies (1917: 55), p.p. (*Mueller*, McAdam Range)]

[*C. sporobolus* auct. non R. Br.: Bentham (1878: 281), p.p. min.; Ewart & Davies (1917: 56), p.p. (*Mueller*, Upper Victoria River)]

Tall, slender perennial, tufted, 70–115 cm high, with spikelets usually viscid at maturity. *Culms* trigonous to terete, smooth, 1.5–3.5 mm diam. *Leaves* flat or canaliculate or occasionally carinate, mostly septate-nodulose, ≤ culms, to 4.5 mm wide, yellow-green to mid-green; midrib often not obvious abaxially, but if obvious then often more strongly aculeate than margins; marginal prickles sparse to dense, regularly spaced (0.1–1.0 mm apart), very short to short, <0.05–0.1 mm long, antrorse to erect, aculeate to papillate; leaf sheaths not septate-nodulose, not smooth or shining, stramineous with dark red-brown blotches. *Inflorescence* compound to decompound, often somewhat lax, 8–14(–c.25) slender primary branches to 21 cm long; bracts erect to spreading, 1–3 exceeding the inflorescence. *Spikelets* few to c. 12 in loose, subdigitate, hemispherical or globose clusters of 0.7–2.5 cm diam.; spikelets compressed, oblong, 5-17 mm long, 2.0–2.5 mm wide in side view, (4–)6–26-flowered, usually viscid; rachilla often thickened at maturity (to 0.1 mm thick), not to narrowly winged, wings to 0.05 mm wide; glume spacing 1.0–1.5 mm; spikelet with glumes falling individually and rachilla persistent, or often units of branch plus spikelets falling. *Glumes* ovate to elliptic, retuse to acute with straight mucro <0.1–0.2 mm long, stramineous to golden-brown with green midrib, 1.7–2.3 mm long, 0.5–0.7 mm wide, sides 2–3-nerved with nerves very distinct because of viscidity of spikelet, margins broad-hyaline and not inrolled. *Anthers* 0.4–0.8 mm long excluding appendage 0.1–0.2 mm long. *Nut* ± trigonous, obovate to elliptic with acute apex, adaxial face concave, other faces flat, dark red-brown to black, small-foveate to small-colliculate, shining, 1.5–1.8 mm long, ⅞ as long as to equalling glume, 0.6–0.7 mm diam., often viscid and falling with glume because of viscidity. Figure 20g–i.

Distribution: Kimberley region of Western Australia to Darwin & Gulf region of the Northern Territory. Figure 18e.

Habitat: Sandy to loamy soils; in seasonally wet situations (banks and beds of stream lines).

The species generally has viscid spikelets at maturity. It shares this characteristic with *C. ixiocarpus* (q.v.) and *C. cunninghamii* (q.v.). Superficially, it resembles *C. sexflorus*, but that species has bulbous culm bases and different spikelet details and it occupies a very different habitat. *C. viscidulus* occasionally grows with *C. cunninghamii* subsp. *cheradicus* and *C. holoschoenus*, but is readily distinguished on glume characters.

Selected specimens (34 examined): Northern Territory: Darwin and Gulf: 70 km from Katherine, near Fergus[s]on R., *Blake 16088*, Apr 1946 (BRI, NSW); 6 km S of Edith R. crossing on Stuart Highway, *Wilson 4937, 4939*, Apr 1983 (NSW); 6 km E of Stuart Hway on old track to Edith Falls, *Wilson 4947*, Apr 1983 (NSW). Victoria River: 6 km NE of Mt Frederick, NW Tanami Desert, *Latz 8599, 8600*, Mar 1981 (NT, NSW); Upper Victoria R., *Mueller*, – (K, PERTH); Victoria Highway, 27.6 km NE of Victoria R. crossing, *Wilson 4901*, Apr 1983 (NSW). Western Australia: Gardner: Mitchell Plateau, W of Lone Dingo, *Beard 8317*, Feb 1979 (PERTH); c. 6.5 km W of King R., S side of Cockburn Range, *Beauglehole & Carr 47240*, July 1974 (MEL, NSW, NT); Mitchell R., *Dunlop 5231*, Feb 1980 (NSW); Palmoondoora Creek above Morgan Falls, Drysdale R. National Park, *George 14066*, Aug 1975 (PERTH); junction Neville Creek and Calder R., Eastern Walcott Inlet, *Kenneally 8706*, May 1983 (PERTH); Carson R., 32 km E of new Theda HS., *Telford & Butler 6123*, July 1977 (CBG); 13 km S of Great Northern Highway on Moochalabra Dam road, *Wilson 4875*, Apr 1983 (NSW); Granite Creek, 11.7 km SW of Victoria Highway on Lake Argyle road, *Wilson 4895*, Apr 1983 (NSW). Dampier: Windjina Gorge, Napier Range, *Beauglehole & Carr 47687*, July 1974 (MEL, NSW, NT). Fitzgerald: King Creek Gorge, c. 15 km SW of Bedford Downs HS., *Beauglehole 53607*, June 1976 (NT); Lennard R. Gorge, King Leopold Range, *Beauglehole & Carr*

47753, July 1974 (MEL, NSW, NT); 13.5 miles [22 km] NW of Elgie Cliffs Station, *Lazarides 5103*, Apr 1955 (CANB, BRI, K, MEL, PERTH). Hall: Smoke Creek, SW of Lake Argyle, *Weston 12158*, Apr 1980 (PERTH, CANB).

15. Cyperus carinatus *R. Br.*
Brown (1810: 216); Poiret (1817: 187); Sprengel (1824: 227); Kunth (1837: 112); Steudel (1854: 54); Bentham (1878: 274), p.p. min.; Ewart & Davies (1917: 55), p.p.; Kükenthal (1935–36: 457), p.p.; Wilson (1981a: 508, Figure 638I). *Mariscus carinatus* (R. Br.) C.B. Clarke (1908: 19); Domin (1915: 441), excluding specimens.

TYPE: NORTHERN TERRITORY: North Coast, *R. Brown (Bennett 5899)*; holo BM; iso BRI (fragm.).

[*C. holoschoenus* auct. non R. Br.: Fitzgerald (1918: 117), p.p.]

Tall, robust perennial, tufted, bases rarely somewhat bulbous in young plants, 40–100 cm high, not viscid. *Culms* trigonous to terete, smooth, 1.5–3 mm diam. *Leaves* carinate or canaliculate, strongly septate-nodulose, ≥ culms, to 5 mm wide, bluish green; midrib obvious abaxially, smooth; marginal prickles sparse to dense, irregularly spaced (0.2–1.5 mm apart), short, c. 0.05 mm long, mixed antrorse aculeate and papillate; leaf sheaths mostly septate-nodulose, loose, of papery texture, not shining, pinkish to dark red-purple. *Inflorescence* simple to compound, (3–)6–17 primary branches to 17 cm long; bracts erect, (1–)2–3 exceeding inflorescence. *Spikelets* 12-numerous in ± dense subdigitate, hemispherical clusters of 0.7–2 cm diam.; spikelets compressed, oblong to narrow-ovate, (3.5–)5–9(–14) mm long, 2–4 mm wide in side view, (4–)6–14(–32)-flowered; rachilla usually not thickened (rarely to 0.1 mm thick), not or scarcely winged; glume spacing 0.7–1.2 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* elliptic to ovate, broad-acute to retuse with straight mucro <0.1–0.2 mm long, stramineous to golden brown with green midrib, 1.6-2.3 mm long, 0.4–0.8 mm wide, sides (2–)3–4-nerved, margins inrolled and usually broad white-membranous (margins not obvious in mature spikelets because tightly inrolled around nut). *Anthers* 0.4–0.8 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, very narrow-elliptic to narrow-obovate with broad-acute and subglobose apex, all faces flat or two faces convex, pale yellow-brown to dark red-brown, smooth and reticulate-areolate or small-colliculate, shining, 1.6–2.0 mm long, ≤ glume, 0.5–0.7 mm diam., falling with glume. Figure 21a–c.

DISTRIBUTION: From the Dampier region of Western Australia to the North Kennedy District, Queensland. Figure 18f.

HABITAT: Sandy to clay-loam soils in seasonally wet situations (banks and beds of streams, open swamps, roadside drains).

C. carinatus shows some resemblance to *C. holoschoenus*, *C. orgadophilus*, *C. oxycarpus* (q.v.) and *C. sporobolus*, but is readily distinguished by its glumes, which have broad white-membranous margins that clasp the nut. It is also distinguished from *C. orgadophilus* and *C. sporobolus* by the strongly bulbous culm-bases and shorter culms of the latter species. It differs further from *C. holoschoenus* (with which it often grows) in its blue-green leaves and culms, its mixed leaf marginal prickles, its pinkish bases, longer spikelets, and stouter nut. Depauperate herbarium specimens of *C. carinatus* have been mistaken for *C. fulvus* but the two species differ in glume shape, size and spacing, and in the colour of the culm bases. *C. carinatus* is generally larger and 'softer-textured' than *C. fulvus*, reflecting their different habitats.

The name *C. carinatus* was misapplied to specimens of *C. congestus* Vahl by Nees (in Lehmann 1846: 72) and to *C. subulatus* R. Br. by Boeckeler (1875: 84).

SELECTED SPECIMENS (52 examined): QUEENSLAND: Cook: Gilbert R., Forest Home Station, *Brass 1867*, Apr 1931 (BRI). Burke: Blackbull, between Normanton and Croydon, *Blake 9137*, May 1935 (BRI, K, NSW, NT); 9 miles [15 km] W. Westmoreland Station, *Perry 1279*, June 1948 (CANB, BRI); Leichhardt R., 8 km S of Mt Isa, *Wilson 5441*, May 1983 (NSW). North Kennedy: Balfes Creek township, *Wilson 5596*, May 1983 (NSW). Gregory North: Pigeon Creek, 50 km NW of Dajarra on Mt Isa road, *Wilson 5474*, May 1983 (NSW). NORTHERN TERRITORY: Darwin and Gulf: Nutwood Downs Station, *Blake 17602*, May 1947 (BRI, K); McArthur R. area, c. 1 km from main road, *Craven 3875*, Feb 1976 (CANB); Gulf of Carpentaria, Maria Island, *Dunlop 2847*, July 1972 (NT); 5 km W of Roper Bar, *Parker 919*, June 1980 (CANB); 0.5 km N of Larrimah on Stuart Highway, *Wilson 5276*, May 1983 (NSW); Caranbirini Waterhole, c. 32 km SW of Borroloola, *Wilson 5332*, May 1983 (NSW). Victoria River: Gill Creek Bore, *Latz 5379*, June 1974 (NT, NSW); Victoria Highway, 23.5 km W of Timber Creek, *Wilson 4774*, Apr 1983 (NSW). Barkly Tableland: Calvert Hills Station, Seigal Creek, *Henry 738*, May 1973 (NT, AD); Mitchebo Waterhole, Mittibah Station, *Maconochie 2613*, Mar 1981 (NSW); Stuart Highway, North Hayward (Creek), *Wilson 4690*, Apr 1983 (NSW). Central North: Lander R. floodout, *Henry 639*, Mar 1973 (NT, BRI, CANB, NSW); Frew R., 5 km ENE of Epenarra HS., *Latz 561*, Mar 1970 (NT, BRI, L); Davenport Range, *Latz 6921*, May 1977 (NT, K, NSW); Stuart Highway, 8 km N of Wauchope, *Wilson 4669*, Apr 1983 (NSW). WESTERN AUSTRALIA: Dampier: Molla–Oobagoona road, 6 km N of Gibb R. road, *Beauglehole 52634*, June 1976 (NT); Butler Lake, 'Meda', *Jacobs 4275*, May 1982 (NSW); Deep R., 5 km N of Point Coulomb, *Kenneally 5918*, Apr 1977 (PERTH), *Kenneally 5926*, Apr 1977 (PERTH, NSW); 25 miles [40 km] E of Derby on Beef Road, *Power 241*, Mar 1967 (PERTH).

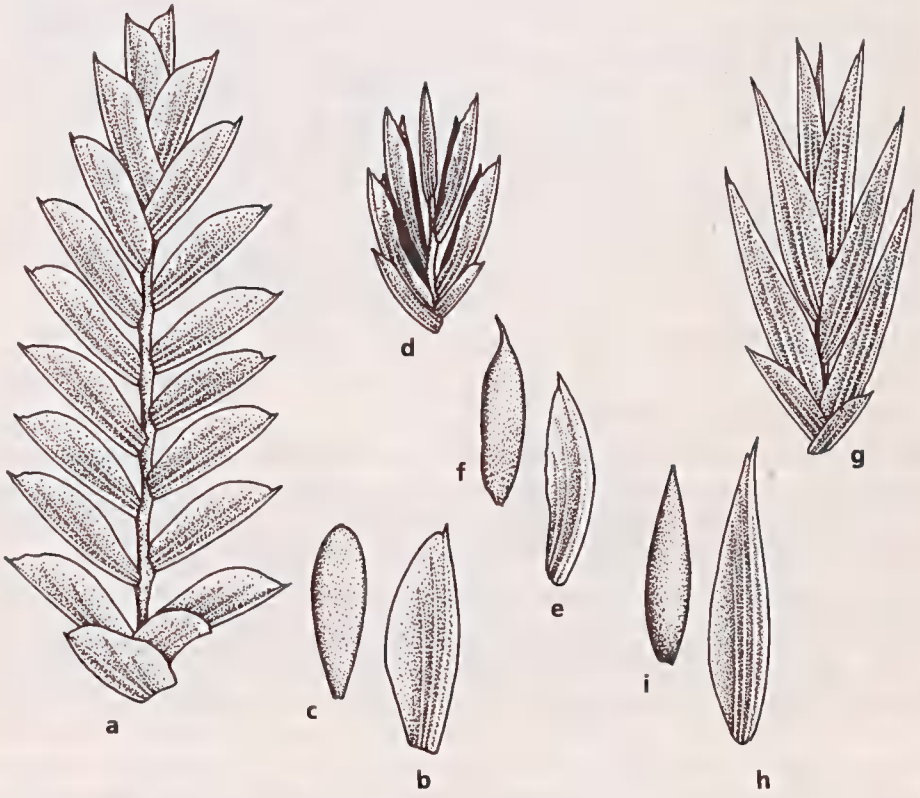


Figure 21. Spikelet details. *C. carinatus*: **a**, spikelet; **b**, glume; **c**, nut. *C. holoschoenus*: **d**, spikelet; **e**, glume; **f**, nut. *C. oxycarpus*: **g**, spikelet; **h**, glume; **i**, nut. **a–c** from *Latz 5531*; **d–f** *Olsen 2723*; **g–i** *Blake 9209*. a, d, g X 11; b, c, e, f, h, i X 14.

Several specimens from the Central North region of the Northern Territory are morphologically intermediate between *C. carinatus* and *C. centralis*, and indicate that the populations there require further study. The inflorescence shape, rather long surculi and long glumes are reminiscent of *C. centralis* but features of the leaves, glumes (other than length) and nuts tend to *C. carinatus*. Seed-set seems to be as high as in any of the taxa regarded as species in this group. The specimens are relatively uniform, and may represent a distinct taxon – perhaps even a stabilised hybrid of these two species. Geographically, most of these specimens occur at the southern limit of distribution of *C. carinatus* (which corresponds to the northern limit of *C. centralis*). *Latz 5264* occurs farther south than the others. The habitat, as seen and as noted on herbarium specimen labels, is closer to that of *C. carinatus* than that of *C. centralis*, but the taxa have not been found growing together.

Cyperus carinatus X C. centralis?

Robust perennial, tufted, often with long surculi, 55–80 cm high, not viscid. *Culms* trigonous to terete, smooth, 1.5–2 mm diam. *Leaves* flat or canaliculate, septate-noulose, about as long as culms, to 4.5 mm wide, bluish green, shining, somewhat fleshy; midrib occasionally obvious abaxially, smooth or scabrous; marginal prickles sparse, usually irregularly spaced, short to long, antrorse, erect, flabellate, aculeate (may be somewhat blunt); leaf sheaths not septate-nodulose, not smooth or shining, thin-textured, pale orange-brown. *Inflorescence* simple to small-compound, 6–11 primary branches to 6 cm long; bracts erect to spreading, 2 exceeding the inflorescence. *Spikelets* numerous in subdigitate, globose clusters of 0.7–1.5 cm diam.; spikelets compressed, oblong, 5–11 mm long, 2.5-3.5 mm wide in side view, 4–10-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 1.3–1.5 mm; spikelet falling as a unit, or with rachilla persistent and glumes falling individually. *Glumes* ovate to elliptic, obtuse with straight mucro ≤0.1 mm long, stramineous to red-brown with yellow blotches and with green midrib, 2.4–3.0 mm long, 0.7–1.1 mm wide, sides 2–3-nerved, margins inrolled and rather broad white-membranous or hyaline. *Anthers* 1.5–2.0 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, narrow-elliptic with broad-acute apex, faces flat, pale brown to dark grey-brown, foveate to smooth and reticulate-areolate, shining or glistening, 1.8–2.0 mm long, about ¾ as long as glume, 0.5–0.7 mm diam., falling with glume.

Distribution: Central North region of the Northern Territory. Figure 18f.

Habitat: Locally wet situations (around waterholes in creeks and around large depressions amongst sand-dunes).

These specimens resemble *C. carinatus* in the following features: leaf colour, width, surface texture, and marginal prickles; nut colour, shape, surface and size; glume width, texture and broad margins. They are similar to *C. centralis* in: glume length; bases with long surculi; general appearance of the inflorescence.

Specimens examined: Northern Territory: Central North: Lander River, *Henry 599*, Mar 1973 (NT, BRI, NSW); Lake Surprise area, *Henry 624*, Mar 1973 (NT, NSW); Elkedra River, *Latz 2239*, Feb 1972 (NT, BRI, NSW); Umbeara Station, *Latz 5264*, May 1974 (NT, NSW); Utopia Station, *Latz 6727*, Mar 1977 (NT, BRI, NSW); Elkedra Station, Davenport Range, *Latz 6974*, May 1977 (NT, NSW); Lake Surprise, *Latz 9888*, May 1984 (NSW ex NT); Sandover Highway, 19 km NE of Utopia turnoff, *Wilson 4647*, Apr 1983 (NSW).

16. Cyperus holoschoenus *R. Br.*

Brown (1810: 215); Poiret (1817: 187); Sprengel (1824: 227); Kunth (1837: 111); Steudel (1854: 54); Mueller (1859: 200); Mueller (1874: 262); Bentham (1878: 273), p.p. max.; Bailey (1902: 1741), p.p. max.; Ewart & Davies (1917: 55); Fitzgerald (1918: 117), p.p.;

Kükenthal (1935–36: 481); Kükenthal (1940b: 463); Blake (1947b: 223); Kern (1963: 27); Kern (1974: 637). *Mariscus holoschoenus* (R. Br.) C.B. Clarke (1908: 19); Domin (1915: 441), p.p. max.

TYPE: NORTHERN TERRITORY: Carpentaria island h [North Island, Sir Edward Pellew Group], *R. Brown (Bennett 5901)*; lecto BM (here designated); iso BM.

Cyperus holoschoenus var. *fuscisquamatus* Kükenthal (1940a: 301), as 'fusci-squamatus'. TYPE: PAPUA: Western Division: Dagwa, Oriomo River, *L. Brass 5920*, Feb–Mar 1934; holo B, n.v.; iso BRI.

Tall, robust perennial, tufted, occasionally with a somewhat bulbous base in young plants, 55–120 cm high, not viscid. *Culms* obscurely trigonous to terete, smooth, 1.5–5 mm diam. *Leaves* canaliculate or occasionally folded, strongly septate-nodulose, ½ - ⅔ length of culms, to 7 mm wide, yellow-green; midrib often obvious abaxially towards the apex and more scabrous than the margins, not obvious below; marginal prickles sparse to very sparse (nearly absent at maturity), regularly spaced (0.3–3.0 mm apart), short, c. 0.05 mm long, antrorse, aculeate; leaf sheaths septate-nodulose, ± smooth and shining, pinkish to red-brown. *Inflorescence* small-compound to decompound, open, 5–11 primary branches to 15 cm long; bracts erect, (1–)2–3 exceeding the inflorescence, occasionally the bracts subtending each spikelet cluster well-developed and obvious when young. *Spikelets* numerous in dense, subdigitate, hemispherical or occasionally globose clusters of 0.2–1.2 cm diam.; spikelets ± compressed, oblong or narrow-ovate, 2.5–5.5 mm long, 1.5–3.0 mm wide in side view, 2–6(–8)-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 0.5–0.9 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic to narrow-ovate, ± curved, spreading widely at maturity (nearly flat), acute with straight mucro <0.1–0.2 mm long, stramineous (yellowish when young) to red-brown with a green midrib (occasionally scaberulous near apex), 1.3–2.1 mm long, 0.4–0.6 mm wide, sides 2–5-nerved, margins not or only slightly inrolled and only very narrow-membranous. *Anthers* 0.4–0.8 mm long excluding appendage <0.1–0.3 mm long. *Nut* trigonous, very narrow- to narrow-elliptic with acuminate apex, usually at least the adaxial face concave, pale red-brown to grey-brown, smooth and reticulate-areolate to small-colliculate, shining, 1.3–2.0 mm long, ≥ glume, 0.4–0.6 mm diam., falling separately from glume or with it. Figure 21d–f.

DISTRIBUTION: From the Kimberley region of Western Australia to the Cook District, Queensland. Also southern New Guinea. Figure 22a.

HABITAT: Sandy to clay soils; seasonally wet sites (banks of streams and lagoons, open swamps).

C. holoschoenus is a distinctive species in its robust habit, and its large inflorescence with small globose spikelet-clusters and small thin-textured glumes that are spread nearly flat at maturity (unlike all other species in this Section). *C. dactylotes* (q.v.) is also robust with small glumes but there the resemblance ends. *C. holoschoenus* often grows with the related *C. carinatus* (q.v.) or *C. oxycarpus*. It can be readily distinguished from both species on glume size, and nut shape and size.

Tate (1890) cited this species as occurring in South Australia. It is likely that he was referring to *C. alterniflorus* or *C. dactylotes*.

SELECTED SPECIMENS (136 examined): QUEENSLAND: Cook: on Wrotham Park, c. 50 miles [80 km] NW of Mungana, *Blake 13708*, Apr 1938 (BRI, K); Lockerbie, 10 miles [16 km] WSW of Somerset, *Brass 18633*, May 1948 (BRI, CANB). Burke: 6 miles [10 km] W of Westmoreland Station, *Perry 1329*, June 1948 (CANB, BRI, NT); Barkly Highway, 46 km SE of Camooweal, *Wilson 5421*, May 1983 (NSW, AD, BRI, NT). North Kennedy: Pentland, *Blake 6046*, June 1934 (BRI, K, NSW); Burra Range, *Sharpe 2835*, July 1981 (BRI, NSW). NORTHERN TERRITORY: Darwin and Gulf: Nutwood

Downs Station, *Blake 17601*, May 1947 (BRI, CANB, K, MEL); 17 miles [27 km] N Wilton R. crossing, *Latz 2758*, June 1972 (CANB, NSW); Emerald R., Groote Eylandt, *Levitt 286*, May 1973 (DNA, NT); King R., 25 miles [40 km] S of Katherine, *McKee 8456*, Feb 1961 (CANB, K, NSW, NT); 1 km S of Ja Ja Billabong, near Jabiluka, *Sanderson NSW 156176*, Mar 1982 (NSW, DNA); Pine Creek, *Tindale & Dunlop 6005*, July 1979 (CANB, K, NSW); 22 km N of Tanumbirini HS., *Wilson 5309*, May 1983 (NSW, AD, BRI, CANB, DNA). Victoria River: Buchanan Highway, 39 km E of Top Springs Roadhouse, *Wilson 4732*, Apr 1983 (NSW); Saddle Creek, Victoria High-

Figure 22. Distribution of: **a**, *C. holoschoenus* (New Guinea occurrences not mapped); **b**, *C. oxycarpus*; **c**, *C. betchei* subsp. *betchei* (open triangles), *C. betchei* subsp. *commiscens* (crosses) and apparent intergrades (open circles); **d**, *C. dactylotes*; **e**, *C. fucosus*; **f**, *C. gunnii* subsp. *gunnii* (crosses) and *C. gunnii* subsp. *novae-hollandiae* (open circles).

way, *Wilson 4783*, Apr 1983 (NSW, DNA, PERTH). Barkly Tableland: Stuart Highway, N Hayward (Creek), *Wilson 4691*, Apr 1983 (NSW, AD, CANB, DNA, K, PERTH). Western Australia: Gardner: Planigale Creek, Drysdale R. National Park, *Kenneally 5597*, Aug 1975 (PERTH, CANB); Longini Landing, near Kalumburu, *Symon 10193*, May 1975 (AD, NSW, NT); Augustus I., Bonaparte Archipelago, *P. Wilson 10836*, May 1972 (PERTH). Fitzgerald: Edkins R., 12 miles [19 km] NW of Glenroy Meatworks, *Lazarides 5152*, Apr 1955 (CANB, BRI, K, NSW, NT, PERTH). Hall: SE Kimberley region, Mabel Downs, Winnama Spring, *Forbes 2033*, May 1984 (NSW ex MEL). New Guinea: Papua New Guinea: Morehead R., c. 8 miles [13 km] inland, Western District, *Pullen 7036*, Aug 1967 (CANB, BRI).

17. Cyperus oxycarpus *S.T. Blake*
Blake (1940: 46)

Type: Queensland: Burke: Wernadinga, between Normanton and Burketown, *S.T. Blake 9209*, 31 May 1935; holo BRI; iso K, MEL, NSW.

[*C. holoschoenus* auct. non R. Br.: Fitzgerald (1918: 117), p.p.]

Tall, robust perennial, tufted, with somewhat bulbous bases when young, 30–80 cm high, not viscid. *Culms* trigonous, smooth, 1.5–2 mm diam. *Leaves* flat to carinate, septate-nodulose, ≥ culms, to 4 mm wide, yellow-green; midrib obvious abaxially, usually smooth; marginal prickles sparse, regularly spaced (0.2–1.5 mm apart), short, 0.05–0.10 mm long, antrorse, aculeate (nearly absent at maturity); leaf sheaths may be septate-nodulose, smooth, shining, yellow-brown to red-brown, with broad whitish membranous margins. *Inflorescence* simple to compound, 5–9 primary branches to 8 cm long; bracts erect, (2–)3–5 exceeding the inflorescence. *Spikelets* numerous in dense subdigitate, hemispherical to globose clusters of 0.5–1.5 cm diam.; spikelets compressed or occasionally subterete in crowded clusters, oblong to narrow-ovate, 4–10 mm long, 2.5–3.5 mm wide in side view, 4–6(–18)-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 0.7–1.2 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* narrow-ovate, long-acute with straight mucro 0.1–0.2 mm long, stramineous, with green midrib, 2.4–3.0 mm long, 0.5–0.7 mm wide, sides (2–)3–4-nerved, margins very narrow-membranous and not or only slightly inrolled, glumes spreading at maturity. *Anthers* 0.4–0.7(–1.2) mm long excluding appendage <0.1(–0.2) mm long. *Nut* trigonous, very narrow-elliptic to narrow-ovate with acuminate apex, faces flat or concave, pale yellow-brown to dark golden-brown, smooth and reticulate-areolate, shining, 1.6–2.2 mm long, ⅔ – ⅞ as long as glume, 0.4–0.5 mm diam., falling with glume. Figure 21g–i.

Distribution: From the regions bordering the Gulf of Carpentaria (Cook, Burke and Darwin & Gulf Districts) to the Kimberley region of Western Australia. Figure 22b.

Habitat: Clayey soils, in seasonally wet sites (banks of lagoons, creek levees, roadside drains).

C. oxycarpus is another robust northern species, related to *C. holoschoenus* (q.v.) and *C. carinatus* (q.v.), and found in similar ephemerally wet habitats. It has a distinctive narrow, elongate nut (as suggested by the epithet) and long glumes that are arranged so as to give a chevron-like appearance to the mature spikelets.

Selected specimens (24 examined): Queensland: Cook: Little R., ESE of Croydon, *Beauglehole 55119*, July 1976 (NT); on Wrotham Park, c. 50 miles [80 km] NW of Mungana, *Blake 13712*, Apr 1938 (BRI); Springmount Station, *Goodall 47*, July 1960 (BRI); c. 10 km W of E Normanby R., 60 km S of Cooktown, *Sharpe 1487*, June 1975 (BRI). Burke: O'Shanassy R., *Blake 8637*, Apr 1935 (BRI); 38 miles [61 km] N of Thorntonia Station, *Perry 1078*, May 1948 (CANB, BRI, MEL, NSW, NT); 51 miles [82 km] N Lawn Hill, *Perry 1129*, June 1948 (CANB, BRI); Harris Lake, 9 km SE of Burketown, *Wilson 5574*, May 1983 (NSW, BRI, DNA). Northern Territory: Darwin and Gulf:

Figure 23. Spikelet details. *C. betchei* subsp. *betchei*: **a**, spikelet; **b**, glume; **c**, nut. *C. betchei* subsp. *commiscens*: **d**, spikelet; **e**, glume; **f**, nut. *C. dactylotes*: **g**, spikelet; **h**, glume; **i**, nut. *C. fucosus*: **j**, spikelet; **k**, glume; **l**, nut. **a–c** from *Wilson 746*; **d–f** *Latz 7090*; **g–i** *Latz 5126*; **j–l** *Wilson 5500*. a, d, g, j X 11; b, c, e, f, h, i, k, l X 14.

O.T. Station, *Blake 17710*, May 1947 (BRI); Leila Lagoon, 63 miles [101 km] SW Borroloola, *Chippendale 5535*, Mar 1959 (NT, AD, BRI, CANB, K, MEL, NSW, PERTH); Tanumbirini Creek, *Latz 7298*, July 1977 (NT, CANB, NSW); just N of S Alligator R. on El Sharana road, *Wilson 5240*, May 1983 (NSW, DNA); Caranbirini Waterhole, *Wilson 5333*, May 1983 (NSW, BRI, DNA, K, P, PERTH). Victoria River: Keep River National Park, *Dunlop 5850*, Mar 1981 (NSW, PERTH ex DNA); Buchanan Highway, 39 km E of Top Springs, *Wilson 4731*, Apr 1983 (NSW, DNA). Barkly Tableland: 90 miles [145 km] E of Newcastle Waters, *Perry 340*, July 1947 (CANB). WESTERN AUSTRALIA: Fitzgerald: Billyara Dam, 'Napier Downs', *Jacobs 5636 & P. Wilson*, May 1988 (NSW). Dampier: Goody Goody, *Fitzgerald 21*, Apr 1905 (PERTH, BRI, NSW); May R., *Fitzgerald 52*, May 1905 (NSW); Meda, *Fitzgerald 401*, Apr 1905 (PERTH).

18. Cyperus betchei *(Kük.) S.T. Blake*
Blake (1940: 43)

Tall perennial, tufted, often forming big tussocks, 35–120 cm high, not viscid. *Culms* trigonous to terete, smooth, 1.2–4 mm diam. *Leaves* flat to carinate or canaliculate, often septate-nodulose, ≤ culms, to 6 mm wide; midrib often obvious abaxially, usually smooth; marginal prickles sparse to dense, regularly or irregularly spaced (0.1–1.6 mm apart), long to short, 0.05–0.2 mm long, antrorse to erect, aculeate or papillate; leaf sheaths ± septate-nodulose, striate or smooth, pinkish to chestnut-brown to black, with margins hyaline or white-membranous at base with red dots. *Inflorescence* small-compound to compound, 4–12 primary branches to 16 cm long; bracts erect to spreading, septate-nodulose, (1–)2–3 much exceeding the inflorescence. *Spikelets* few (4–9) in spicate to subdigitate, loose, hemispherical clusters of 1.5–6.5 cm diam.; spikelets compressed, oblong, (5–)9–43 mm long, 1.2–2.8 mm wide in side view, (6–)10–48-flowered; rachilla not thickened, narrowly to broadly winged, wings 0.05–0.2 mm wide; glume spacing 1.3–2.3 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-ovate to narrow-elliptic, retuse to acute or obtuse with mucro 0.1–0.6 mm long and ± excurved or straight, golden-brown to dark red-brown (or occasionally stramineous) with a green midrib, 2.0–3.4 mm long, 0.5–0.8 mm wide, sides 2–4-nerved, margins not or slightly inrolled and very narrow-membranous. *Anthers* 0.7–1.4 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, very narrow-elliptic to very narrow-obovate with long-acute to acute apex, faces flat, pale yellow-brown, colliculate to smooth and reticulate-areolate, shining, 1.8–2.5 mm long, ¾ as long as to equalling glume, 0.4–0.5 mm diam., falling with glume. Figure 23a–f.

DISTRIBUTION: Northern edge of the arid zone, extending to the Pilbara region of Western Australia and in the east to the Pilliga Scrub area, northern New South Wales. Figure 22c.

C. betchei is closely related to *C. dactylotes*. It can be distinguished by its more obvious abaxial leaf midrib, its inflorescence with the usually larger but sparser clusters of spikelets, the often longer spikelets with more flowers, the greater glume spacing, the usually longer glume mucro, longer anthers and nut, and its often longer surculi.

Plants of subsp. *betchei* differ in aspect from those of the closely related subsp. *commiscens*: the leaf bases are usually not smooth, the culms are relatively more slender, the inflorescences are smaller, spikelets are narrower, and glume spacing is often greater. The differences are slight but are sufficient to give a different facies to specimens. Specimens from north-eastern Queensland (mapped as 'apparent intergrades', Figure 22c) generally have the characters of subsp. *betchei* except that the leaf bases are smooth as in subsp. *commiscens*.

The subspecies of *C. betchei* can be distinguished as follows:

1 Spikelet width 1.2–2.0 mm in side view; glume mucro 0.1-0.2 mm long; leaf bases usually striate; rachilla wings 0.1–0.2 mm wide; culm diameter 1.3–2.7 mm; inflorescence usually relatively small and compact, with 4–7 primary branches to 10 cm long ..... **a.** subsp. **betchei**

1 Spikelet width 2.0–3.2 mm in side view; glume mucro 0.2–0.5 mm long; leaf bases usually smooth; rachilla wings <0.05–0.10 mm wide; culm diameter 1.4–4.0 mm; inflorescence usually large and spreading with (5–)8–12 primary branches to 16 cm long ..... **b.** subsp. **commiscens**

18a. C. betchei subsp. **betchei**

Cyperus betchei (Kük.) S.T. Blake (1940: 43); Wilson (1987: 1135); Sharpe (1989: 324, Figure 47H). *C. angustatus* R. Br. var. *betchei* Kükenthal (1935–36: 452).

Type: New South Wales: North Western Plains: Narrabri, *E. Betche NSW 153088*, Jan 1883; lecto NSW (Blake 1940); isolecto MEL.

[*C. dactylotes* auct. non Benth.: Moore & Betche (1893: 448), p.p.]

Tall slender perennial, 35–100 cm high. *Culms* 1.3–2.7 mm diam. *Leaves* flat to canaliculate; midrib obvious abaxially, scabrous or smooth; marginal prickles irregularly spaced (0.1–0.9 mm apart), long, 0.1–0.2 mm long, antrorse, aculeate; leaf sheaths striate or occasionally smooth, pinkish to chestnut-brown to black. *Inflorescence* small-compound to compound, 4–7 primary branches to 10 cm long; bracts (1–)2–3 exceeding the inflorescence. *Spikelets* in very loose clusters of 2.5–6.5 cm diam.; spikelets (5–)9–43 mm long, 1.2–2.0 mm wide in side view, 10–45-flowered; rachilla broadly winged, wings 0.1–0.2 mm wide; glume spacing 1.6–2.3 mm. *Glumes* narrow-ovate to narrow-elliptic, retuse to obtuse with mucro 0.1–0.2 mm long and straight to excurved, yellow to dark golden-brown, 2.5–3.4 mm long, sides 2–3-nerved, margins ± inrolled and very narrow-membranous. *Anthers* 0.8–1.4 mm long. *Nut* very narrow-elliptic with long-acute apex, 1.9–2.2 mm long, ⅞ as long as glume to equalling glume length. Figure 23a–c.

Distribution: Central and south-eastern Queensland (south from about the Tropic of Capricorn) to the northern part of the Pilliga Scrub in New South Wales. Figure 22c.

Habitat: Sandy-loam to clay soils; in at least seasonally wet situations (banks of creeks, billabongs, roadside drains, floodways).

Selected specimens (38 examined): Queensland: Leichhardt: Nine Mile Creek, 14 km N of Banana, *Wilson et al. 3637*, May 1981 (NSW). Burnett: 32 miles [51 km] N of Chinchilla, *McDonald 455*, Feb 1970 (BRI, AD, CANB, K, NSW); c. 1.5 km SE of Abercorn, *Wilson & Sharpe 3749*, May 1981 (BRI, NSW). Wide Bay: 1.5 km NE of Didcot, *Forster 38*, May 1986 (NSW ex BRI). Darling Downs: Chinchilla, *Blake 7668*, Feb 1935 (BRI, K); 7 Mile Rocky Creek near Chinchilla, *Lithgow*, Nov 1977 (BRI 230426); Surcingle Creek, c. 10 km N of Chinchilla, *Sharpe & Simon 2525*, Feb 1979 (K, NSW ex BRI); between Inglewood and Milmerran, *White 9692*, Jan 1934 (BRI, CANB, K); 1.5 km W of Baking Board railway siding, *Wilson et al. 3397*, Apr 1981 (NSW, BRI, K, P); 10 km W of Dulacca on Roma road, *Wilson et al. 3406*, Apr 1981 (NSW, BRI). Maranoa: 20 miles [32 km] W of Mitchell, *Blake 10970*, Apr 1936 (BRI); 5 km E of Wallumbilla, *Wilson et al. 3416*, Apr 1981 (NSW). New South Wales: North Western Slopes: rail crossing c. 4 km from Kenebri, *Wilson 740*, Nov 1974 (NSW, P). North Western Plains: Sandy Creek, 9 km SSE of Narrabri, *Coveny & Roy 8664*, Nov 1976 (NSW, K, P); 28 km N of Baradine on Pilliga road, *Payne 4*, Jan 1976 (NSW, BRI, K, L, P, US); Talluba Ck, 17 km E of Pilliga on Wee Waa road, *Wilson 6062*, Nov 1984 (NSW, P); 5 km SSW of Pilliga–Wee Waa road on 'Tregoen' road, *Wilson 6059*, Nov 1984 (NSW, P).

Possible intergrades with subsp. *commiscens*:

QUEENSLAND: Leichhardt: Nebo Shire, 'Wavering Downs', *Anderson*, Feb 1978 (BRI 231414). Mitchell: Geera, E of Barcaldine, *Blake 10373*, Dec 1935 (BRI); Springvale, *Clemens*, Apr. 1946 (K); Tower Hill, *White*, Apr 1919 (BRI 186381, 186382); Dandy Creek, c. 1 km S of Eastmere HS., *Wilson & Sharpe 3548*, May 1981 (NSW, BRI, P).

18b. C. betchei subsp. **commiscens** *K.L. Wilson*, **subsp. nov.**

Subsp. *betchei* maxime similis sed basibus foliorum laevibus, culmis robustioribus, inflorescentiis longioribus, spiculis latioribus, intervallo inter glumas saepe minor, differt.

TYPE: NORTHERN TERRITORY: Barkly Tableland: Stuart Highway, 16 km NW of Banka Banka P.O., *K.L. Wilson 4709*, 19 Apr 1983; holo NSW; iso BRI, K. Figure 24a.

C. dactylotes Bentham (1878: 273), p.p. min. (*McDougall Stuart*, Attack Creek).

[*C. dactylotes* auct. non Benth.: Domin (1915: 428), p.p. min.; Ewart & Davies (1917: 55), p.p. (*McDougal* [sic], Attack Creek); Kükenthal (1935–36: 452), p.p. min. (*McDougall Stuart 73*, Attack Creek); Wilson (1981a: 506), p.p.]

[*C. fulvus* auct. non R. Br.: Mueller (1874: 268), p.p. min. (*Stuart*, Attack Creek); Mueller & Tate (1890: 106); Mueller in Tate (1896: 181), as to *Tietkens*, Glen Helen]

Robust perennial, 70–120 cm high. *Culms* 1.4–4 mm diam. *Leaves* flat to strongly folded, bright mid-green; midrib ± obvious abaxially, smooth; marginal prickles regularly spaced (0.1–0.5(–1.6) mm apart), short, 0.05–0.10 mm long, antrorse to erect, aculeate or papillate; leaf sheaths ± smooth, shining, pinkish to purple-red-brown at base. *Inflorescence* compound, (5–)8–12 primary branches to 16 cm long; bracts 2–3 exceeding the inflorescence. *Spikelets* in loose clusters of 1.5–6 cm diam.; spikelets 8–40 mm long, 2.0–2.8 mm wide in side view, (6–)12–48-flowered; rachilla narrowly to broadly winged, wings 0.05–0.10 mm wide; glume spacing 1.3–2.0 mm. *Glumes* narrow-ovate to narrow-elliptic, retuse to acute, with straight mucro 0.2–0.5 mm long, sides 2–4-nerved, stramineous to golden to red-brown, 2.0–3.2 mm long, margins narrow-membranous and not inrolled. *Anthers* 0.7–1.3 mm long. *Nut* very narrow-elliptic to very narrow-obovate with acute apex, 1.8–2.5 mm long, ⅔ – ⅞ as long as glume. Figure 23d–f.

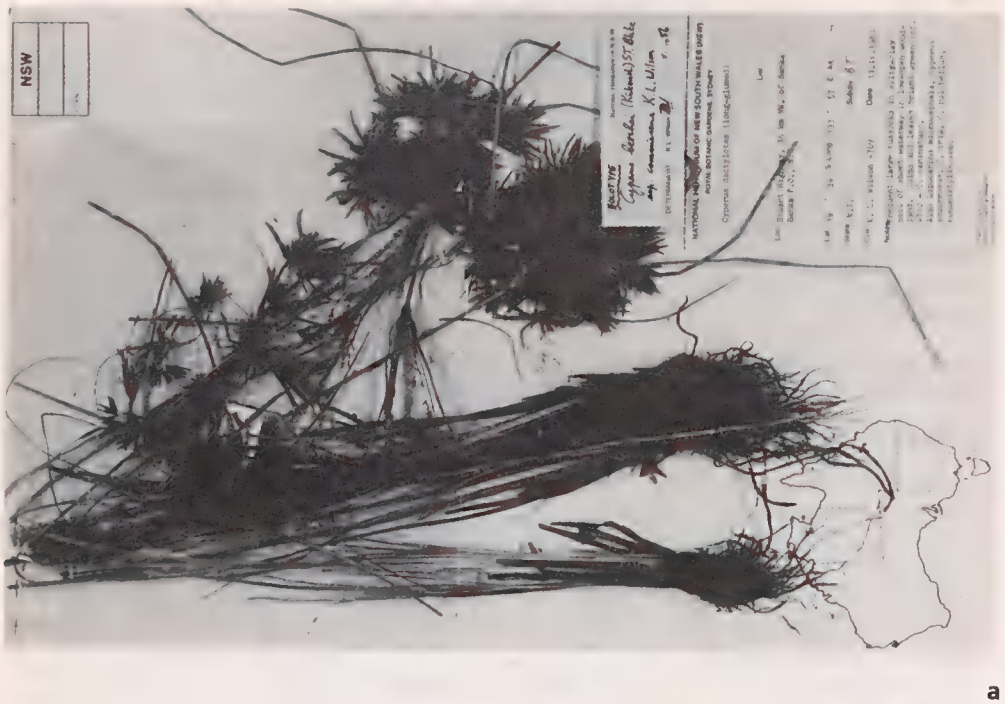
DISTRIBUTION: Most common in Central Australia, Barkly Tableland and Victoria River regions of the Northern Territory, extending to north-western Queensland (N of the Tropic of Capricorn), and scattered in central Western Australia. Figure 22c.

HABITAT: Sandy-loam to clayey soils; in seasonally wet situations (on banks of creeks and waterholes, in swamps).

The epithet is derived from the Latin *commiscens*, mixing or mingling, in recognition of the close relationship and past confusion between this taxon and subsp. *betchei* and *C. dactylotes*.

Specimens in other herbaria have often been labelled by me as 'C. dactylotes (long-glumed form)'.

The subspecies may grow with *C. carinatus*, *C. holoschoenus* and *C. oxycarpus* but is readily distinguished on spikelet and glume characters. In northwestern Queensland, it occasionally grows with *C. dactylotes* or *C. fucosus*. Two specimens, *K. Wilson 5484* (Qld) and *Latz 9522* (N.T.), show some approach to *C. carinatus* in their broader glumes, stouter habit and strongly septate-nodulose leaves. These may represent hybrids



a

b

Figure 24. Holotype of **a**, *C. betchei* subsp. *commiscens*; **b**, *C. fucosus*.

between these two species. The few specimens that I have seen from Western Australia have a slightly different facies but the differences seem insufficient to recognise any infraspecific taxon formally.

SELECTED SPECIMENS (58 examined): QUEENSLAND: Burke: Barkly Highway, 11 km SE of Buckley R., *Wilson 5423*, May 1983 (NSW, AD, BRI, NT); Leichhardt R., 8 km S of Mt Isa, *Wilson 5439*, May 1983 (NSW, BRI, DNA, K); Little Creek, 19 km NW of Riversleigh HS., *Wilson 5543*, May 1983 (NSW, BRI, DNA, PERTH). Gregory North: 22 km N of Wills Creek on Duchess–Mt Isa road, *Wilson 5455*, May 1983 (NSW, BRI). NORTHERN TERRITORY: Darwin and Gulf: Tanumbirini Creek, Cox River Station, *Latz 7317*, July 1977 (NSW ex NT). Victoria River: Buchanan Highway, 39 km E of Top Springs Roadhouse, *Wilson 4730*, Apr 1983 (NSW). Barkly Tableland: 43 miles [69 km] S Mallapunyah HS., *Chippendale*, Mar 1959 (NT 5560, AD, BRI, CANB, MEL, NSW, PERTH); Attack Creek, *McD. Stuart*, 1876 (K, BRI, MEL); Stuart Highway, 16 km NW of Banka Banka P.O., *Wilson 4709*, Apr 1983 (NSW, BRI, K). Central North: Frew R., 3 miles [5 km] ENE Epenarra HS., *Latz 660*, Mar 1970 (NT, BRI); Murray Downs Station, *Latz 6915*, May 1977 (K, NSW); 1.9 miles [3 km] E of Wycliffe Creek crossing, *Nelson 690*, Apr 1963 (NT, AD, BRI, CANB, MEL, NSW); Hanson R., c. 1 km WNW of Stuart Monument, *Wilson 4660*, Apr 1983 (NSW, AD, BRI, CANB, K, NT). Central South: pool at S end of Serpentine Gorge, *Henshall 1946*, Apr 1976 (NT). WESTERN AUSTRALIA: Mueller: Djaluwon Creek, near S end of Lake Gregory, *George 15391*, Apr 1979 (PERTH, CANB, NT). Fortescue: 20 km E of Balfour Downs HS., *P. Wilson 10366*, Aug 1971 (PERTH). Keartland: Rudall R., *George 10712*, May 1971 (PERTH, CANB). Ashburton: 75 miles [121 km] S of Mundiwindi, *Burbidge 6076*, May 1958 (CANB, BRI). Austin: Uramurdah Creek, *Craven 5222*, Apr 1978 (CANB).

19. Cyperus dactylotes *Benth.*

Bentham (1878: 273), p.p. max., excluding McDougall [sic] Stuart specimen; Bailey (1902: 1741); Domin (1915: 428, Figure 99), p.p.; Kükenthal (1935–36: 452), p.p.; Black (1943: 144), Black (1978: 261); Blake (1947a: 43); Wilson (1981a: 506), p.p.; Cunningham et al. (1981: 158).

TYPE: QUEENSLAND: Bowen Downs, *Birch*; lecto K (here designated); isolecto BRI, MEL.

C. clelandii J. Black (1924: 253); Black (1929: 676). TYPE: SOUTH AUSTRALIA: Cordillo Downs, *J.B. Cleland*, 22 May 1924; holo AD 97413001.

[*C. diphyllus* auct. non Retz.: Bentham (1878: 279), p.p. (*Gosse* specimen)]

[*C. gunnii* auct. non Hook. f.: Ewart & Davies (1917: 55), p.p. (*Hill 298*)]

More or less robust perennial, tufted, often forming large tussocks, 45–100 cm high, not viscid. *Culms* terete throughout or trigonous near the apex, smooth, 2.5–4.5 mm diam. *Leaves* flat or canaliculate or occasionally carinate, septate-nodulose, ≤ culms or occasionally shortly exceeding the culms, to 6.5 mm wide, mid-green; midrib occasionally obvious abaxially, smooth (rarely scabrous); marginal prickles sparse to dense, regularly spaced (0.1–0.9 mm apart), short, 0.05–0.10 mm long, antrorse, aculeate; leaf sheaths septate-nodulose, striate or smooth and shining, stramineous (may be pinkish brown at base), margins white-membranous with red spots or brown with age. *Inflorescence* compound to decompound, 4->15 primary branches to 14 cm long; bracts erect to spreading, usually septate-nodulose, (2–)3–5 at times nearly as long as the culms. *Spikelets* few to numerous in ± loose, subdigitate, hemispherical to globose clusters of 1–3(–4) cm diam.; spikelets compressed, oblong, 5–12(–26) mm long, 1.2–2.2 mm wide in side view, 6–20(–46)-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 0.9–1.3 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-ovate to elliptic, retuse to acute with straight mucro <0.1–0.2 mm long, stramineous to golden-brown (rarely dull red-brown at maturity) with green midrib, 1.3–2.1 mm long, 0.5–0.7 mm wide, sides 2–3-nerved, margins ± inrolled and membranous. *Anthers* 0.3–0.5 mm long

excluding appendage ≤0.1 mm long. *Nut* trigonous, narrow-elliptic to narrow-obovate with acute to broad-acute apex, faces flat, yellow-brown to dark golden-brown, colliculate to foveate, glistening, 1.3–1.6 mm long, ¾ – ⅞ as long as glume, 0.4–0.5 mm diam., falling with glume. Figure 23g–i.

DISTRIBUTION: Widespread in central and western Queensland (occasional on the NE coast), Central Australia (Central North and South), Barkly Tableland, NE corner of South Australia and NW corner of New South Wales, occasional in the Kimberley and Pilbara regions of Western Australia. Figure 22d. Probst (1949) records *C. dactylotes* as a wool-alien in Kettwig in 1932; Ryves (1976) lists the species as a wool-alien at Blackmoor Fruit Farm, N Hants., England.

HABITAT: Sandy-loam to clayey soils; in at least seasonally wet situations (banks of creeks, borrow-pits and waterholes, floodways, gilgais, and roadside drains).

C. dactylotes is closely related to *C. fucosus* and *C. betchei* (q.v.). It is distinctive in its combination of robust habit and small, bright yellow to dark golden-brown glumes. It further differs from *C. fucosus* in the number of long inflorescence bracts, in the prickles on the leaf and bract margins, and in the glume apex, which is more acute in *C. dactylotes* and produced in a straight mucro. *C. dactylotes* is occasionally found growing with *C. centralis* (q.v.)., *C. carinatus* and *C. holoschoenus* but is readily distinguishable on spikelet and glume characters.

A minor mystery surrounds the specimens used by Bentham in describing *C. dactylotes*. Bentham's description is complete, implying that he saw at least some whole specimens ('leaves rather long, but only sent with very few specimens'). I have seen all the cited specimens (in K or MEL) and they consist only of inflorescences. The fate of any complete specimens is not known; Bentham, in the Concluding Preface to his *Flora* (1878), says that he had returned numerous consignments to Melbourne 'without a single loss' en route.

SELECTED SPECIMENS (117 examined): QUEENSLAND: Cook: Bullock Creek, *Correll*, Oct 1969 (BRI 154642). Burke: Barkly Highway, 46 km SE of Camooweal, *Wilson 5420*, May 1983 (NSW, AD, BRI, DNA, H, K, P, UB). North Kennedy: Rita Island, 12 km S of Ayr, *Sharpe 1566*, June 1975 (BRI). South Kennedy: western side of Hannans Gap, *Wilson & Sharpe 3584*, May 1981 (NSW). Gregory North: Pigeon Creek, 50 km NW of Dajarra, *Wilson 5476*, May 1983 (NSW). Gregory South: Wilsons R. near Nocundra, *Carolin 4310*, Aug 1964 (SYD). Mitchell: Romulus Tableland, 50 km SE of Blackall, *Beeston 1451*, July 1975 (BRI). Leichhardt: Panorama Creek Overflow, *Wilson et al. 3621*, May 1981 (NSW, BRI). Maranoa: 5 km E of Walumbilla, *Wilson & Sharpe 3415*, Apr 1981 (NSW, BRI, H, K, L, P, UB, US). Warrego: 13 km W of Morven, *Wilson et al. 3463*, Apr 1981 (NSW, BRI, H, K, P). NEW SOUTH WALES: North Far Western Plains: Tero Creek Station, *Martensz 4134*, Dec 1968 (CANB, NSW). NORTHERN TERRITORY: Victoria River: 70.5 miles [113 km] NE Tanami, *Chippendale 5710*, Apr 1959 (NT, AD, BRI, MEL, NSW). Barkly Tableland: Lancewood Creek, *Latz 1656*, July 1971 (NT, CANB). Central North: Boomerang Waterhole, Lander R., *Chippendale 4782*, July 1958 (NT, AD, BRI, MEL, NSW). Central South: Reedy Rock Hole, George Gill Range, *Beauglehole 26618*, July 1968 (NSW). SOUTH AUSTRALIA: Lake Eyre: Bradys Waterhole, Cordillo Downs, *Basedow 57*, Oct 1919 (K, NSW). WESTERN AUSTRALIA: Gardner: King Edward R., Mitchell Plateau road, *Beauglehole 51918*, June 1976 (NT). Dampier: Fitzroy River at Noonkanbah, *Gardner 7102*, May 1944 (PERTH). Hall: East branch Wolf Creek, c. 60 km S Halls Creek, *Beauglehole & Carr 47336*, July 1974 (NSW). Mueller: Wolf Creek, c. 3 km WSW of crater, *George 15348*, Apr 1979 (PERTH, CANB, NT). Fortescue: Joffre Falls, Hamersley Range National Park, *Beauglehole & Carr 48758*, Aug 1974 (NSW, NT).

20. Cyperus fucosus *K.L. Wilson*, **sp. nov.**

A *C. dactyloti* colore glumarum, habitu graciliore, bracteis involucralibus longis 1–2, apice glumae obtusiore, differt.

TYPE: QUEENSLAND: Burke: Seymour River, 22 km N of Thorntonia HS. on Burketown road, *K.L. Wilson 5501*, 18 May 1983; holo NSW; iso BRI, H, K, L, P, UB. Figure 24b.

[*C. carinatus* auct. non R. Br.: Bentham (1878: 274), p.p. min.; Bailey (1902: 1742), p.p.; Ewart & Davies (1917: 55), p.p. (*Gulliver* collections)]

Tall but not very robust perennial, tufted, 65–90 cm high, not viscid. *Culms* terete, smooth, 1–3.3 mm diam. *Leaves* canaliculate or carinate, somewhat septate-nodulose, about as long as culms, to 4 mm wide, bright yellow-green to mid-green; midrib occasionally obvious abaxially, smooth (rarely scabrous); marginal prickles very sparse to sparse (often absent below), irregularly spaced (0.9–2.0 mm apart), short, c. 0.05 mm long, antrorse to erect, aculeate; leaf sheaths mostly not septate-nodulose, dull, striate, stramineous above, red-brown to purplish below, margins white-membranous with red spots or brown with age. *Inflorescence* small-compound to decompound, 4->15 primary branches to 14 cm long; bracts erect to spreading, usually septate-nodulose, 1–2 exceeding inflorescence. *Spikelets* few (3–10) in loose hemispherical clusters of 1–3.5 cm diam.; spikelets compressed, oblong, 7–26 mm long, 1.7–2.5 mm wide in side view, 8–26(–40)-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 0.9–1.3 mm; spikelet with rachilla persistent and glumes falling individually. *Glumes* elliptic to narrow-ovate, retuse to broad-acute with straight or excurved mucro ≤0.1 mm long, usually dull red-brown or occasionally stramineous, with green midrib, 1.8–2.8 mm long, 0.4–0.5 mm wide, sides 2–3-nerved, margins ± inrolled and membranous. *Anthers* 0.3–0.7 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, very narrow- to narrow-elliptic with acute to acuminate apex, faces flat, pale yellow-brown to dark golden-brown, tuberculate to foveate, glistening, 1.4–1.7 mm long, c. ⅞ as long as glume, 0.4–0.5 mm diam., falling with glume. Figure 23j–l.

DISTRIBUTION: Around the Gulf of Carpentaria in the Northern Territory and Queensland. Figure 22e.

HABITAT: Sandy-loam to clayey soils; on seasonally wet sites (beds and banks of creeks, waterholes, lagoons and floodways).

The epithet refers to the characteristic colour of the glumes and lower leaf sheaths, as well as to the confusion of this taxon with *C. angustatus* and *C. dactylotes*. It comes from the Latin *fucosus*, a purplish red colour (from the alga *Fucus*) and also, secondarily, painted or disguised.

The species is closely related to *C. dactylotes*, differing from that in glume colour (never bright yellow), the retuse to broad-acute glume apex, the fewer involucral bracts, the irregular prickles on the leaf margins, the more slender habit, and the striate leaf sheaths (which are red-brown to purplish towards the base). These species are not sympatric so far as known, although their distributions come very close to overlapping.

At times, *C. fucosus* has been confused in the herbarium with *C. angustatus* but can be readily distinguished by its tufted habit, its lesser glume spacing, its nut shape and size, and its glumes, whose membranous margins tend to inroll and hold the nut. It occasionally grows with *C. carinatus* and *C. holoschoenus*, which both tend to be more robust than it and are readily distinguished on spikelet features.

Specimens examined: Queensland: Burke: Glenore near Normanton, *Blake 9119*, May 1935 (BRI, MEL); 14 miles [22 km] NW of Corinda on Westmoreland road, *Carolin 9139*, May 1974 (SYD, K, NSW); towards Croydon from Esmeralda (13 miles [21 km]), *Blake 19608*, July 1954 (BRI); Nicholson River area, *Henshall 249*, June 1974 (NT, BRI); 38 miles [61 km] N of Thorntonia Station, *Perry 1084*, May 1948 (CANB, BRI, K); Seymour R., 22 km N of Thorntonia HS., *Wilson 5500*, May 1983 (NSW, BRI, DNA, H, K, L, P, PERTH, UB), *Wilson 5501*, May 1983 (NSW); Little Creek, 19 km NW of Riversleigh HS., *Wilson 5544*, May 1983 (NSW, BRI, DNA, K, P, PERTH); Norman River, *Gulliver 29*, (BRI 199666); between the Norman and Gilbert Rivers, *Gulliver 41*, 1874 (MEL 92157). Northern Territory: Darwin and Gulf: Nutwood Downs Station, *Blake 17599*, May 1947 (BRI); Cox River Station, *Latz 7233*, July 1977 (NT, BRI, NSW).

21. Cyperus gunnii *J.D. Hook.*
Hooker (1858: 80, pl. 140A)

Tall but relatively slender perennial, tufted, forming big tussocks, deep-rooted, 80–180 cm high, not viscid. *Culms* triquetrous to terete, smooth or occasionally slightly scabrous, often septate-nodulose, 1.7–4 mm diam. *Leaves* carinate, occasionally flat or canaliculate, strongly septate-nodulose, ≥ culms, to 7 mm wide, yellow-green; midrib usually obvious, usually scabrous; marginal prickles dense to sparse, ± regularly spaced (0.1–1.4 mm apart), long to short, 0.05–0.15 mm long, strongly and coarsely antrorse aculeate (often worn-down on mature leaves and then easier to feel than to see); leaf sheaths septate-nodulose, ± smooth and shining, orange-brown to grey-brown, occasionally stramineous above, margins near base narrow-membranous and red-brown. *Inflorescence* simple to compound, 5–12 primary branches to 12 cm long; bracts ± erect, septate-nodulose, 2–3 much exceeding the inflorescence. *Spikelets* numerous in ± dense, spicate to subdigitate, hemispherical to globose clusters of 0.7–3 cm diam.; spikelets compressed, oblong to narrow-ovate, 6–12(–20) mm long, 1.0–2.5 mm wide in side view, 4–12(–28)-flowered; rachilla not thickened, narrowly or occasionally broadly winged, wings to 0.2 mm wide; glume spacing 1.2–2.2 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic, broad-acute with straight mucro <0.1–0.2 mm long, stramineous to red-brown, with green midrib, 2.0–2.7(–3.2) mm long, 0.5–0.9 mm wide, sides 2–4-nerved, margins ± inrolled and narrow-membranous. *Anthers* 0.7–1.5 mm long excluding appendage <0.1 mm long. *Nut* trigonous, narrow-elliptic to very narrow-elliptic with acute to acuminate apex, faces flat or slightly convex, pale yellow-brown to dark brown, colliculate to smooth and reticulate-areolate, shining, 1.5–2.2 mm long, c. ¾ – ⅞ as long as glume, 0.3–0.7 mm diam., falling with glume. Figure 25a–f.

Distribution: Along the Queensland east coast S from Cairns and inland to the Darling Downs, extending through the eastern half of New South Wales to Victoria, Tasmania and the South-eastern and Southern Lofty regions of South Australia. Figure 22f. Recorded once in New Zealand, apparently naturalised. Ryves (1976) records this species as a wool-alien at Blackmoor Fruit Farm, N Hants., England.

Ewart (1931) gives the common name of this species as 'Flecked Leaf-rush', which seems contrived and inappropriate. Willis (1962, 1970) gives this name as an alternative, preferring the equally unattractive 'Flecked Flat-sedge'.

Bentham (1878) cited a specimen, *'Cunningham*, In the interior' (K!), under this species but it is actually *C. victoriensis* C.B. Clarke. A specimen *'Birch*, Barcoo Downs' cited by Domin (1915) and Kükenthal (1935–36) as *C. gunnii* is probably also *C. victoriensis* (or perhaps the closely related species *C. bifax*).

The two subspecies of *C. gunnii* are allopatric (see Figure 51). Morphologically, they can be distinguished as follows:

1 Spikelets deep red-brown, 1.5–2.5 mm wide in side view, 6–12(–24)-flowered, forming dense clusters; nut diam. 0.5–0.7 mm; nut apex acute; leaves with sparse to dense marginal prickles, 0.1–1.4 mm apart ..... **a.** subsp. **gunnii**

1 Spikelets stramineous or pallid red-brown, 1.0–1.5 mm wide, 4–28-flowered, forming loose clusters; nut more slender, 0.3–0.4 mm diam., with long-acute to acuminate apex; leaves with dense marginal prickles, 0.1–0.5 mm apart ..... **b.** subsp. **novae-hollandiae**

Figure 25. Spikelet details. *C. gunnii* subsp. *gunnii*: **a**, spikelet; **b**, glume; **c**, nut. *C. gunnii* subsp. *novae-hollandiae*: **d**, spikelet; **e**, glume; **f**, nut. *C. alterniflorus*: **g**, spikelet; **h**, glume; **i**, nut. *C. lhotskyanus*: **j**, spikelet; **k**, glume; **l**, nut. **a–c** from *NSW 65255*; **d–f** *Blake 14481*; **g–i** *Wilson 2675*; **j-l** *NSW 22678*. a, d, g, j X 11; b, c, e, f, h, i, k, l X 14.

21a. C. gunnii subsp. **gunnii**
Cyperus gunnii J.D. Hooker (1858: 80, pl. 140A); Bentham (1878: 283), p.p.; Bailey (1902: 1747), p.p.; Rodway (1903: 238); Black (1929: 90), (1943: 144), (1978: 263, Figure 229), p.p.; Ewart (1931: 214); Kükenthal (1935–36: 449), p.p.; Willis (1962: 222), (1970: 222); Burbidge & Gray (1970: 79); Healy & Edgar (1980: 187); Cunningham et al. (1981: 161); Beadle et al. (1982: 602, 606); Wilson (1987: 1128, Figure 482E); Sharpe (1989: 326). *C. lucidus* R. Br. var. *gunnii* (Hook. f.) Moore & Betche (1893: 449). *Mariscus gunnii* (Hook. f.) C.B. Clarke (1908: 18). *Mariscus gunnii* var. *typicus* Domin (1915: 442), p.p. max.

TYPE: TASMANIA: Penquite, near Launceston, *Gunn 1403*; holo K; iso BRI, HO, NSW.

[*C. decompositus* auct. non R. Br.: Boeckeler (1870: 333), as *C. compositus*, sphalm.]

[*C. nodulosus* F. Muell. ex Bentham (1878: 283), nom. nud.]

[*C. lucidus* auct. non R. Br.: Mueller (1874: 270), p.p.; Mueller (1875: 53), p.p.]

Culms trigonous to terete. *Leaves* to 6.5 mm wide; marginal prickles sparse to dense (0.1–1.4 mm apart), short, 0.05–0.10 mm long, very strongly aculeate. *Inflorescence* simple to compound, 5–8 primary branches to 12 cm long. *Spikelets* numerous in dense, subdigitate, ± globose clusters of 0.7–2(–3) cm diam.; spikelets 1.5–2.5 mm wide in side view, 6–12(–24)-flowered; rachilla narrowly to broadly winged, wings 0.05–0.10(–0.2) mm wide; glume spacing 1.2–2.2 mm. *Glumes* red-brown to dark red-brown (rarely stramineous), 2.0–2.7(–3.2) mm long, 0.5–0.9 mm wide. *Anthers* 0.8–1.5 mm long. *Nut* 1.5–2.2 mm long, c. ¾ as long as the glume, 0.5–0.7 mm diam., apex acute. Figure 25a–c.

DISTRIBUTION: South-eastern Queensland to Tasmania, and the South-eastern region of South Australia, with outlying occurrences in the Southern Lofties of South Australia and on the Murray River near Mildura. Also one record from the North Island of New Zealand (considered to be an introduction by Healy & Edgar (1980)). Figure 22f.

HABITAT: Sandy to loam soils; beside semi-permanent water (creek banks, floodways, swamps, roadside drains).

Subsp. *gunnii* differs from subsp. *novae-hollandiae* in its broader and often fewer-flowered spikelets that are nearly always red-brown (unlike the often pallid spikelets of *novae-hollandiae*) and that form much denser clusters. Its glumes are usually broader than in *novae-hollandiae* and its nut is of greater diameter. So far as seen, subsp. *gunnii* differs in habit from subsp. *novae-hollandiae*, forming more spreading tussocks and therefore giving the appearance of being a much shorter plant. In both subspecies, the inflorescence bracts are very long (up to 65 cm long) but they are relatively much longer in subsp. *gunnii* where they may nearly equal the length of the culms.

Subsp. *gunnii* occasionally grows with or near *C. lhotskyanus*. The two taxa can be distinguished readily in the field by the tussock-forming habit of subsp. *gunnii* and the shortly rhizomatous habit of *C. lhotskyanus*. Subsp. *gunnii* is more robust in general habit but is smaller in many of its floral parts (spikelet width, glume length and width, mucro length, nut diameter), has more regularly antrorsely aculeate marginal prickles on the leaves, and has much longer inflorescence bracts. There is also some similarity to *C. alterniflorus* (q.v.).

SELECTED SPECIMENS (217 examined): QUEENSLAND: Moreton: at Durundur Lagoon, *Leichhardt*, Oct 1843 (MEL). Darling Downs: Crawlers Creek, c. 7 km SW of Cecil Plains, *Wilson 1379*, Oct 1975 (NSW, BRI). Maranoa: Coffin Gully, 0.5 km N of Ogilvie road junction, *Wilson et al. 3429*, Apr 1981 (NSW). NEW SOUTH WALES: North Coast: near Branxton, *Goode 254*, Dec 1954 (BM, NSW). Central Coast: 1 km S of Leppington, *Johnson & Edgar 7251*, Oct 1971 (CHR, NSW). South Coast: Boydtown turnoff from Princes Highway, *Wilson 2251*, Feb 1979 (NSW, BRI, CHR, K, MEL, P).

Northern Tablelands: Parlour Mountains, vicinity Boorolong, *Gray 3891*, Jan 1956 (CANB, NSW). Central Tablelands: Beaconsfield–Burraga, Campbells R., *Carolin 928*, Mar 1959 (SYD). Southern Tablelands: Delegate Common, *Forsyth*, Jan 1910 (NSW 122277, BRI, K, MEL). Central Western Slopes: Grenfell–Gooloogong road, just N of Bald Hills turnoff, *Wilson 4439*, Apr 1982 (NSW, P). South Western Slopes: Murray R. on Khancoban–Corryong road, *Wilson 2054*, Feb 1979 (NSW, K, MEL, P). North Western Plains: Bebo State Forest, E of Yetman, *Coveny & P. Wilson 11688*, Nov 1983 (NSW, BRI). South Western Plains: Humbug (Euglo) Creek c. 5.5 km direct SW of Winnunga, *Wilson 5626*, Nov 1983 (NSW, BRI, H, K, L, NY, P, UB). Victoria: A: Kings Billabong, pumping station at Psyche Bend, *Johnson & Wilson 7977*, Feb 1975 (NSW, MEL, P). D: Mathers Creek Reserve, Balmoral, *Beauglehole 50348*, Oct 1975 (NSW). E: Darlots Creek Sanctuary, Etterick, *Melville et al. 1674*, Oct 1952 (K, MEL, NSW). H: Kooyoora–Melville Caves State Park, *Beauglehole 69458*, Oct 1981 (NSW). J: Fyans Creek in Halls Gap Valley, *Symon 1867*, Nov 1961 (AD). K: Hopkins River, Framlingham Forest, *Wilson 6806*, Mar 1986 (NSW). L: Barmah State Forest, 30 km NNW of Numurkah P.O., *Beauglehole 64289*, June 1979 (MEL, NSW). N: c. 3 km SSE of Lal Lal, *Beauglehole 61771*, Nov 1978 (MEL, NSW). P: 1.4 km W along Gum Flats Road from Forest Road, N of Anglesea, *Wilson 6827*, Mar 1986 (NSW). R: Yackandandah, *Meebold 21664*, Nov 1936 (NSW). U: 7 km SSE of Walwa P.O., *Beauglehole 68485*, May 1980 (MEL, NSW). V: 24.5 km S of Colac Colac on Omeo road, *Wilson 2066*, Feb 1979 (NSW, CHR, K, MEL, P). Z: c. 4 km from Genoa on Mallacoota road, *Wilson 2206*, Feb 1979 (NSW, CHR, K, MEL, P). Tasmania: Westbury, *Curtis*, Feb 1948 (HO); bank of S Esk River at Perth, *Curtis and Cameron*, Feb 1979 (HO); Ouse, *Mason 13204A*, Jan 1977 (HO); Lake House near Cressy, *Perry*, Apr 1947 (CANB); Liffey, *Rodway 164*, Jan 1931 (CANB, K); Meander River flats, *Somerville*, Jan 1959 (HO). South Australia: Northern Lofty: S Para R., crossing at border of Para Wirra National Park, *Spooner 1220*, Jan 1971 (AD). Southern Lofty: Millbrook Reservoir, c. 20 km NE of Adelaide, *Symon 2071*, Mar 1962 (AD). Murray: Tailem Bend, *Ising*, Feb 1926 (AD 966150123). South-eastern: 2.5 km SE of Glencoe on Mt Gambier road, *Wilson 6106*, Feb 1985 (NSW). New Zealand: North Island: Okaihau, Bay of Islands Co., *Esler CHR 284143*, Nov 1970 (CHR).

21b. C. gunnii subsp. **novae-hollandiae** *(Boeck.) K.L. Wilson*, **comb. et stat. nov.**

Basionym: *Cyperus novae-hollandiae* Boeckeler (1870: 344), as 'Novae Hollandiae'; Boeckeler (1875: 86); Mueller (1875: 54); Bentham (1878: 282); Bailey (1902: 1746).

Mariscus gunnii var. *novae-hollandiae* (Boeck.) Domin (1915: 443, as 'Novae-Hollandiae'). *C. gunnii* var. *novae-hollandiae* (Boeck.) Kükenthal (1935–36: 450). Type: Queensland: North Kennedy: Rockingham Bay, *Dallachy* [given in protologue as 'Rockingham Bay, *F. Mueller*']; lecto MEL (here designated); isolecto K, MEL, ?P.

Culms triquetrous to trigonous. *Leaves* to 7 mm wide; marginal prickles dense (0.1–0.5 mm apart), long to short, 0.10–0.15 mm long, strongly aculeate. *Inflorescence* small-compound to compound, 5–12 primary branches to 12 cm long. *Spikelets* c. 10 in spicate to subdigitate, ± loose, hemispherical to globose clusters of 1.2–3 cm diam.; spikelets 1.0–1.5 mm wide in side view, 4–24-flowered; rachilla narrowly winged, wings c. 0.05 mm wide; glume spacing 1.5–2.0 mm. *Glumes* stramineous to red-brown, 2.1–2.7 mm long, 0.5–0.6 mm wide. *Anthers* 0.7–1.3 mm long. *Nut* 1.6–2.1 mm long, c. ⅞ as long as glume, 0.3–0.4 mm diam., apex long-acute to acuminate. Figure 25d–f.

Distribution: Scattered along the eastern coast of Queensland, from near Cairns to Bundaberg. Figure 22f.

Habitat: Margins of coastal swamps, often with *Melaleuca quinquenervia*, in water to 0.5 m deep for at least part of the year. Dovey (1935) describes the species in the Bottle Creek area (N of Bundaberg) as 'not common, around clay waterholes in gum-topped Box [*Eucalyptus moluccana*] country on slate with indifferent drainage'.

Despite the bombing of B during World War II, at least some apparently original sheets of Boeckeler's herbarium still exist there. However, no relevant type material of this taxon has been located there.

SELECTED SPECIMENS (27 examined): QUEENSLAND: Cook: Innisfail, *Blake 14481*, Nov 1941 (BRI, NT), *Flecker 7733*, Dec 1941 (AD); Black Mountain road, near Kuranda, *Brass 33745*, Jan 1968 (BRI); Biboohra via Cairns, *Wallon*, Dec 1930 (BRI 187341). North Kennedy: 9.5 km E of Tully, *Boyland 563*, Nov 1967 (BRI, K); 4 km E of Proserpine, *Byrnes & Clarkson 3886*, Apr 1978 (BRI); 9 km S of Ingham just W of Bruce Highway, *Lazarides 8102*, July 1976 (BRI,CANB); Allingham, ESE of Ingham, *Moriarty 1573*, Jan 1974 (BRI); Goorganga Plains, c. 7 km S of Lethebrook Creek on Bruce Highway, *Russell 520*, Sep 1978 (BRI); Cromarty, *White 8852*, Mar 1933 (BRI). Port Curtis: Rockhampton, *Dietrich 640* (B), *Dietrich 642* (BRI, K, L, MEL), *Thozet*, 1873 (BRI 166097, K, MEL); Rosedale area, *Dovey 711*, Dec 1935 (BRI); Eulalah Creek, c. 5 km NW of Wartburg, *Sharpe & Elsol 2684*, Mar 1981 (NSW); near Wartburg on N side of Baffle Creek, *Wilson & Sharpe 3789, 3790*, May 1981 (NSW).

22. Cyperus alterniflorus *R. Br.*

Brown (1810: 216); Poiret (1817: 188); Sprengel (1824: 227); Kunth (1837: 112); Steudel (1854: 54), as 'alternifolius'; Bentham (1878: 275), p.p. max.; Tate (1890: 181), p.p.; Bailey (1902: 1742), p.p.; Black (1922: 89), p.p.; Kükenthal (1935–36: 455), ?p.p.; Blackall & Grieve (1954: 50); Cunningham et al. (1981: 156); non Schweinitz (1824). *Mariscus alterniflorus* (R. Br.) C.B. Clarke (1908: 18); Domin (1915: 441).

TYPE: QUEENSLAND: Shoalwater Bay, East Coast, *R. Brown (Bennett 5898)*; holo BM.

C. pictus Steudel (1854: 43); non Tenore (1824–29). TYPE: WESTERN AUSTRALIA: *J. Drummond coll. III n. 335*; holo P; iso, E, G, K, MEL, TCD.

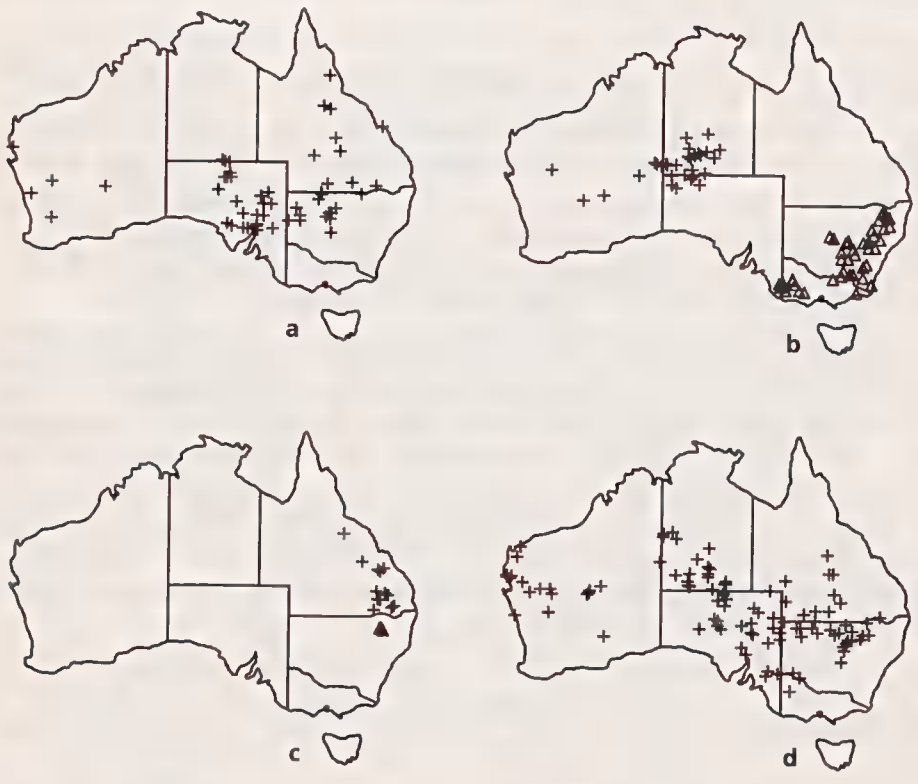


Figure 26. Distribution of: **a**, *C. alterniflorus*; **b**, *C. lhotskyanus* (open triangles) and *C. centralis* (crosses); **c**, *C. secubans* (open triangles) and *C. isabellinus* (crosses); **d**, *C. rigidellus*.

C. clarus S.T. Blake (1940: 44), p.p. min. (Goyinga Mountains and South Australian specimens).

[*C. fulvus* auct. non R. Br.: Bentham (1878: 274), p.p. min. (*Victorian Expedition*, Gojinga [sic] Mountains)]

[*C. gunnii* auct. non J. D. Hook: Kükenthal (1935–36: 449), p.p. min. (*Koch 391*, Mt Lyndhurst); Black (1978: 263), p.p.]

[*C. rutilans* auct. non (C.B. Clarke) Maiden & Betche: Kükenthal (1935–36: 455), p.p. min. (*Koch 391*, Mt Lyndhurst); Blake (1943: 53), p.p.; Black (1943: 145), p.p., (1978: 267), p.p.]

Robust perennial, tufted, forming big tussocks (may be shortly rhizomatous), deep-rooted, 30–150 cm high, often viscid near base. *Culms* triquetrous (to trigonous), smooth or scabrous at the apex, 2.0–5 mm diam. *Leaves* strongly folded to carinate, strongly septate-nodulose, ≥ culms, to 12 mm wide, yellow-green; midrib obvious abaxially and scabrous; marginal prickles dense or more rarely sparse, regularly spaced (0.05–0.9 mm apart), long, 0.1–0.2 mm long, often coarse, antrorse, aculeate (less commonly irregularly short-papillate); leaf sheaths septate-nodulose (less obvious in smaller plants), smooth above, striate and/or fibrous below, mostly not shining, red-brown or red-purple (especially when young) to grey-brown. *Inflorescence* compound to decompound, occasionally small-compound or simple, 3–8 primary branches to 15 cm long; bracts erect to spreading, 2–4 much exceeding the inflorescence. *Spikelets* 6-numerous in spicate to subdigitate, ± dense hemispherical to globose clusters of 1–5 cm diam.; spikelets compressed, oblong to narrow-ovate, 5–17(–35) mm long, 1.8–4.0 mm wide in side view, 6–18(–48)-flowered, occasionally viscid; rachilla not thickened, not to broadly winged, wings to 0.1 mm wide; glume spacing 1.0–1.9 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* broad-elliptic to elliptic, broad-acute to obtuse, with mucro <0.1–0.4 mm long and somewhat excurved, golden-brown to red-brown with a green midrib, 2.0–3.5 mm long, 0.6–1.2 mm wide, sides (2–)3–4-nerved, margins ± inrolled and very narrow-membranous. *Anthers* 1.1–1.8 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, narrow-elliptic to narrow-obovate with broad-acute apex, faces flat, pale red-brown to dark brown, tuberculate, glistening to dull, 1.6–2.3 mm long, c. ¾ as long as glume, 0.5–0.7 mm diam., falling with glume. Figure 25g–i.

Distribution: From near Irvinebank (North Kennedy region, Queensland) southwest through western New South Wales to the Flinders and Gawler Ranges of South Australia; a few scattered records in southern Western Australia. Figure 26a.

Habitat: Sandy to clay-loam soils; in at least seasonally wet sites (floodways, stream banks, rocky gullies).

Robert Brown labelled the type of *C. alterniflorus* as having been collected by him at Shoalwater Bay (north of present-day Rockhampton). This is, indeed, the only likely landing place for him to have collected this otherwise inland species. The relatively dry coastal belt around Rockhampton has many such species (Johnson 1964). This species has not been re-collected there, but that may be due to difficulty of access to army land, as that area is now. Comparison of Peter Good's diary (Edwards 1981) and Flinders' published account and charts (1814) suggests that the specimen was probably collected on the western side of Shoalwater Bay, either towards the Normanby Range or Pine Mount. Good's diary mentions that their party (including Brown) 'fell in with a Brook ... full of Stones' during their walk 'towards some high hills' [probably the Normanby Range] and that they found 'plenty of fresh water in pools and Creeks' on their way to Pine Mount. Both of these habitats would be suitable for this species.

C. pictus was described by Steudel from Drummond's specimen *'Third Collection No. 335'*, collected at the south-western extreme of the distribution of *C. alterniflorus*. Erickson (1969) states that Drummond's Third Collection comprised 14 sets of 350 specimens collected from 'N and E of Bolgart, K.G.S. [King George Sound], Stirling Ra., Porongorups, C. Riche and Mt Manypeaks'. Of those localities, 'N and E of Bolgart' is the most likely for *No. 335*.

Kükenthal (1935–36: 455) cites a specimen 'Vasse River, *Lindley*' under *C. alterniflorus*. I have not seen the specimen but it is likely to be *C. congestus* Vahl rather than this species. There is a specimen 'Vasse River, *Molloy*' in CGE that is *C. congestus* but it had not been previously determined as *C. alterniflorus*.

C. alterniflorus is morphologically close to *C. gunnii* and *C. lhotskyanus* and has frequently been mis-identified as those species. It can be distinguished from *C. gunnii* by its coarser habit and generally larger parts. Its glumes are relatively broader than in *C. gunnii* and the mucro is generally longer. It can be distinguished from *C. lhotskyanus* by its generally taller and coarser tufted habit and lack of rhizomes, its leaf bases, which are red-brown to grey-brown with age and tend to become stout and fibrous with age (never pinkish and papery textured as in *C. lhotskyanus*), and its regularly and closely antrorsely aculeate leaf marginal prickles. It also shows similarities to *C. centralis* (q.v.).

The species is widely distributed in terms of geography and environmental conditions and, as one might expect, varies morphologically over its range. Deciding on the status of regional variants is made difficult by the shortage of mature specimens in herbaria: about 90% of the specimens examined had only immature flowers. Specimens from the north-east extreme of the distribution (including the type specimen) appear more slender, and the spikelets look more open with small glumes (1.9–2.6 mm long, 0.6–0.8(-1.0) mm wide in side view). These specimens always have a short glume mucro (≤0.1 mm long), and leaf marginal prickles are sparser and more irregular. However, prickles can vary on the one leaf from long-aculeate near the apex to shorter and blunter towards the base (e.g. *Wilson 1674, 3576*), which could be an effect of weathering or of differential deposition of silica. The specimen *Correll T126*, at the north-eastern extreme of the species' range, differs from other eastern collections in being relatively slender, with leaves not strongly septate-nodulose, bases striate and not deeply rooted, and glumes more slender with finer nerves on the sides.

Specimens from the western limit of distribution of the species in South Australia and Western Australia generally differ from the typical specimens of the eastern part of the distribution in having marginal prickles on the leaves that are shorter, erect, papillate or blunt-aculeate and very irregularly spaced. They also tend to have very yellow to golden glumes with a shorter mucro and more slender bases (which give the plants a very different appearance).

Selected specimens (103 examined): Queensland: Burke: Micky Spring, White Mtns area N of Hughenden, *Godwin C2687*, Aug 1984 (NSW). North Kennedy: W of Pentland between Warrigal and Burra, *Blake 9947*, Oct 1935 (BRI, K, MEL). Mitchell: Alice R., just E of Alice railway siding, *Wilson et al. 3575-3577*, May 1981 (NSW). Maranoa: Bollon, *Swarbrick 5149*, Sep 1970 (BRI). Warrego: 1 mile [1.5 km] W of Eulo on Thargomindah road, *Phillips NSW 65101*, Sep 1963 (NSW). New South Wales: North Western Plains: Moonie R., 'Goondabluie', *McGillivray 2814*, Nov 1967 (NSW, BRI, K). South Western Plains: Warranary Hills, c. 5 km direct WNW of Roto, *Wilson & Murray 5892*, Mar 1984 (NSW). North Far Western Plains: 1 mile [1.5 km] W of Mootwingie Historic Site HQ., *De Nardi 875*, Sep 1971 (NSW, BRI, K); Paroo R. billabong, Wanaaring, *Milthorpe & Cunningham 5175, 5176*, May 1977 (NSW). South Australia: Lake Eyre: Todmorden Station, 42 km W of Oodnadatta, *Henshall 3486*, May 1980 (NSW). Gairdner-Torrens: 2.9 km SW of Millars Creek HS., *Chinnock 2589*, Sep 1975 (AD). Flinders Ranges: Gammon Ranges, Arcoona Creek, *Eichler 12682*, Sep 1956 (AD); lower slopes Mt John, Wilpena, *Symon 618*, Sep 1960 (AD, K).

Eastern: Panaramitee, c. 10 km SE of Yunta, *Gardiner 6*, Aug 1962 (AD). Eyre Peninsula: Hiltaba Station, c. 2 km NW of HS., *Blaylock 1982*, Sep 1972 (AD). Western Australia: Carnarvon: flats of Gascoyne R., Carnarvon, *Aplin 1559*, May 1962 (PERTH). Austin: 70 km W of Mt Magnet on Yalgoo road, *Wilson 2623*, Sep 1979 (NSW, CHR, K, P, PERTH). Helms: 3 miles [5 km] E of Laverton, *George 4465*, June 1963 (PERTH, BRI). Irwin: 30 km SE of Mingenew on Three Springs road, *Wilson 2675*, Oct 1979 (NSW, K). Avon: near Mt Caroline, *Sewell*, 1889 (MEL, BRI).

Plants found along the stream lines from Oodnadatta north to Charlotte Waters and New Crown Station just over the S.A.–N.T. border appear morphologically intermediate between *C. alterniflorus* and *C. centralis* (q.v.) and require further study. The plants are generally stout and deep-rooted as in *C. alterniflorus* but have bases of a rather papery texture as found in *C. centralis*. The leaf marginal prickles are more or less densely antrorsely aculeate and irregularly spaced. The inflorescences generally have the look of *C. centralis* and the nut is nearly as long and narrow as in *C. centralis*. Glumes are yellow to dark golden-brown (never red-brown). Specimens of this taxon were listed by Eardley (1946: 157) as *C. alterniflorus* and '*C. dactylotes* forma vel sp. aff.', based on Blake's determinations. The specimen '*Staer*, Oodnadatta' was referred (with some doubt) to *C. clarus* by Blake (1943: 53) and Black (1943). Bentham (1878) and Ewart & Davies (1917) cited under *C. fulvus* a specimen (*Giles*, Charlotte Waters, n.v.) that may belong to this taxon.

Specimens of Oodnadatta form: Northern Territory: Central South: Charlotte Waters, *Crocker*, May 1939 (AD 97447289, BRI), *Giles*, 1875 (MEL); New Crown Station, *Latz 6861*, Apr 1977 (NT, NSW). South Australia: Lake Eyre: Oodnadatta, *Andrew*, May 1936 (AD 97519318), *Cleland*, Oct 1945 (AD 96226084), *Staer (herb. Black)*, Jan 1913 (AD 97519089); Woorong Creek, Mt Clarence area, WNW Coober Pedy, *Beauglehole 20148*, Oct 1966 (NT); Abminga Creek, *Crocker*, June 1939 (AD 97545504); Abminga [c. 10 km S of border], *Ising*, July 1976 (AD 966021513); Oodnadatta, beside Neales, *Knight 183*, Dec 1977 (AD); Mt Dare HS., Abminga Creek, *Latz 4810*, Apr 1974 (NT); near Horn Expedition Camp 2, S of Macumba Hill, *Tate*, May 1894 (AD 96014160); The Neales, 7 km SW of Oodnadatta, *Wilson 4612*, Apr 1983 (NSW, AD); The Neales (S Branch) c. 70 km W of Oodnadatta, *Wilson 4613*, Apr 1983 (NSW, AD).

23. Cyperus lhotskyanus *Boeck.*

Boeckeler (1884: 498); Wilson (1980: 664); Cunningham et al. (1981: 162); Beadle et al. (1982: 606); Wilson (1987: 1129).

Type: Nova Hollandia, *Lhotsky*; holo KIEL.

Mariscus rutilans C.B. Clarke (1908: 18); Domin (1915: 443). *Cyperus rutilans* (C.B. Clarke) Maiden & Betche (1916: 28); Blake (1943: 53), p.p.; Black (1943: 145), p.p., (1978: 267), p.p.; Kükenthal (1935-36: 455, Figure 50G–H), p.p. max.; Willis (1962: 222), (1970: 222); Burbidge & Gray (1970: 79). Type: New South Wales: Armidale, *Perrott*, as 'Parrott'; lecto K (Wilson 1980: 664).

[*Cyperus gunnii* auct. non Hook. f.: Bentham (1878: 283), p.p. min. (*Parrott*, Armidale; *Moore*, Liverpool Plains)]

Slender perennial, shortly rhizomatous with solitary culms or tufted, 20–65 cm high, not viscid; bases sometimes slightly subbulbous, dark red-brown; rhizomes short, black, fibrous. *Culms* trigonous to subterete below, smooth, 1.2–3 mm diam. *Leaves* flat to carinate, occasionally septate-nodulose, shorter than to longer than culms, to 4 mm wide, bluish green; midrib usually obvious abaxially, smooth or scabrous towards apex; marginal prickles dense to sparse, irregularly spaced (0.1–1.4 mm apart), short, 0.05–0.10 mm long, antrorse to erect or flabellate, aculeate; leaf sheaths not or occasionally septate-nodulose, dull, whitish or stramineous above, purplish red-brown below with hyaline margins red-brown near apex. *Inflorescence* simple to compound, 3–7(–12) primary branches to 11 cm long; bracts erect to spreading, (1–)2(–3) about

twice as long as the inflorescence. *Spikelets* numerous in subdigitate, dense, hemispherical to globose clusters of 1–2.5(–4) cm diam.; spikelets compressed, oblong, 6–12(–25) mm long, 2.5–4 mm wide in side view, 6–10(–30)-flowered; rachilla not thickened, not to broadly winged, wings to 0.15 mm wide; glume spacing 1.2–1.6(–2.0) mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-ovate to elliptic, retuse to acute with straight or excurved mucro 0.1–0.5 mm long, red-brown with green midrib, 2.6–4.0 mm long, 0.8–1.0 mm wide, sides 2–4-nerved, margins loosely inrolled and narrow-membranous. *Anthers* 1.3–1.7 (–2.0) mm long excluding appendage ≤0.1 mm long. *Nut* trigonous, narrow-obovate to narrow-elliptic with acute apex, faces flat, yellow-brown, colliculate to smooth and reticulate-areolate, shining, 1.8–2.1(–2.5) mm long, c. ¾ as long as glume, 0.6–0.8 mm diam., falling with glume mostly. Figure 25j–l.

Distribution: Extending from the Tablelands and Western Slopes of New South Wales to south-eastern South Australia. Figure 26b. Probst (1949) lists this species as a wool-alien at Derendingen, Switzerland, in 1926 and 1927 (as *C. rutilans*). Ryves (1976) similarly lists this species for Blackmoor Fruit Farm, N Hants., England.

Habitat: Sandy to clay soils; in seasonally wet sites (creek banks, floodways).

This species is related to *C. alterniflorus* (q.v.), *C. gunnii* (q.v.) and *C. secubans* (q.v.). It is readily distinguished in the field from all these species by its shortly rhizomatous habit.

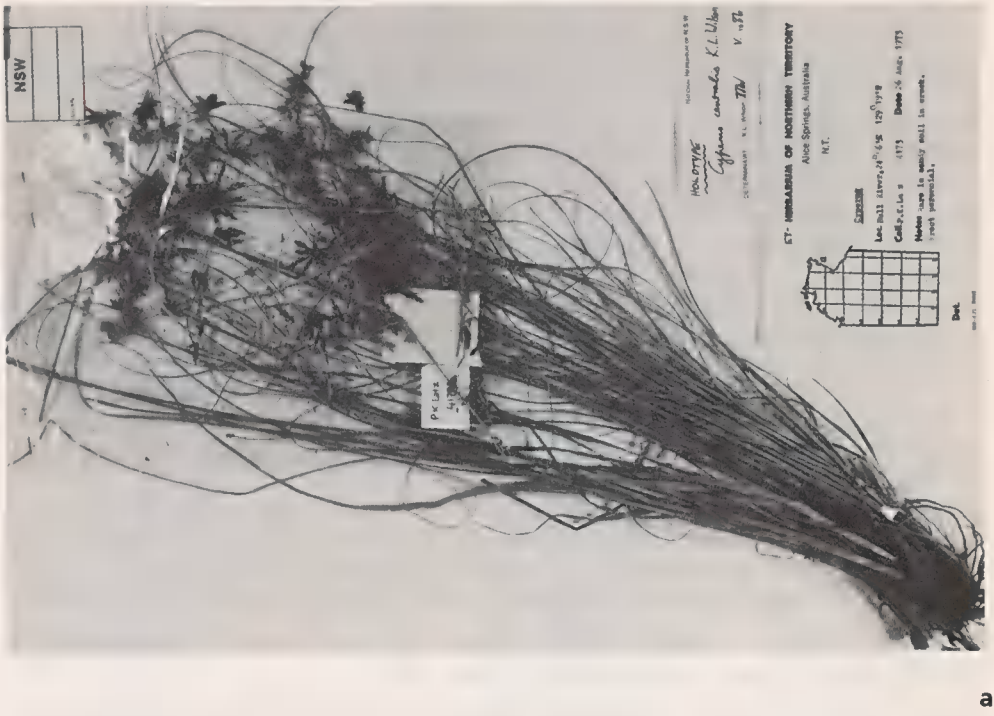
Kükenthal (1935–36) cited *Koch 391* under this species. However, Koch used species numbers rather than collection numbers and he obviously had a confused idea of the taxon he was collecting. Most sheets under that number belong to *C. alterniflorus* but one sheet is *C. victoriensis* C.B. Clarke; none is *C. lhotskyanus*. Kükenthal also cited *Dietrich 615*, from Port Mackay, under this species. I have not seen the specimen but it is likely to be *C. subulatus* R. Br. or some other species from another Section.

Selected specimens (96 examined): New South Wales: Central Coast: Wolgan R., Newnes, c. 1600 ft [485 m] alt., *Johnson*, Nov 1959 (NSW 65140). South Coast: Eden to Pambula, *Maiden*, Nov 1901 (NSW 22683, K). Northern Tablelands: Ollera Creek, 4.5 km S of Wandsworth on Guyra road, *Wilson 4330*, Jan 1982 (NSW, H, K, P). Central Tablelands: Orange, *Boorman*, Jan 1908 (NSW 122306, BRI, K, P). Southern Tablelands: near Tharwa, A.C.T., *Blake 7540*, Feb 1935 (BRI, K, NSW, NT, PERTH). North Western Slopes: Tower Hill Creek, 3.5 km W of Nullamanna turnoff on Strathbogie–Bukkulla road, *Wilson 6226*, May 1985 (NSW, NE). Central Western Slopes: Denman, *Earp NSW 30931*, Feb 1955 (NSW, BRI, K); 5 km along Tullamore road from Condobolin–Parkes road, *Wilson 5956*, Nov 1984 (NSW, H, K, P, UB). South Western Slopes: Ardlethan, *Boorman*, Nov 1917 (NSW 15644, K). South Western Plains: Humbug (Euglo) Creek c. 5.5 km direct SW of Winnunga, *Wilson 5625*, Nov 1983 (NSW, H, K, P); Sandy [Crowl] Creek, 10 km NW of Lachlan Downs HS., *Wilson & Murray 5891*, Mar 1984 (NSW). Victoria: C: Wonwondah East, *Wilson & Johnson 1077*, Feb 1975 (NSW, MEL). J: Narrampumelap, 11 km SSW of Willowra P.O., *Beauglehole 61630*, Nov 1978 (MEL, NSW). R: Winton Swamp, 9 miles [15 km] ENE of Benalla, *Aston WS 35*, Feb 1959 (MEL). U: Walwa, *McBarron 1303*, Dec 1947 (BRI). W: Orbost, on the Snowy R. flats, *Hunter*, Dec 1943 (MEL). South Australia: South-eastern: c. 1.5 km S of Naracoorte Caves, *Hunt 2261*, Nov 1964 (AD, BRI, CANB, K); Wrattonbully, c. 30 km SSE of Naracoorte, Gurrs Swamp, *Hunt 2338*, Jan 1965 (AD).

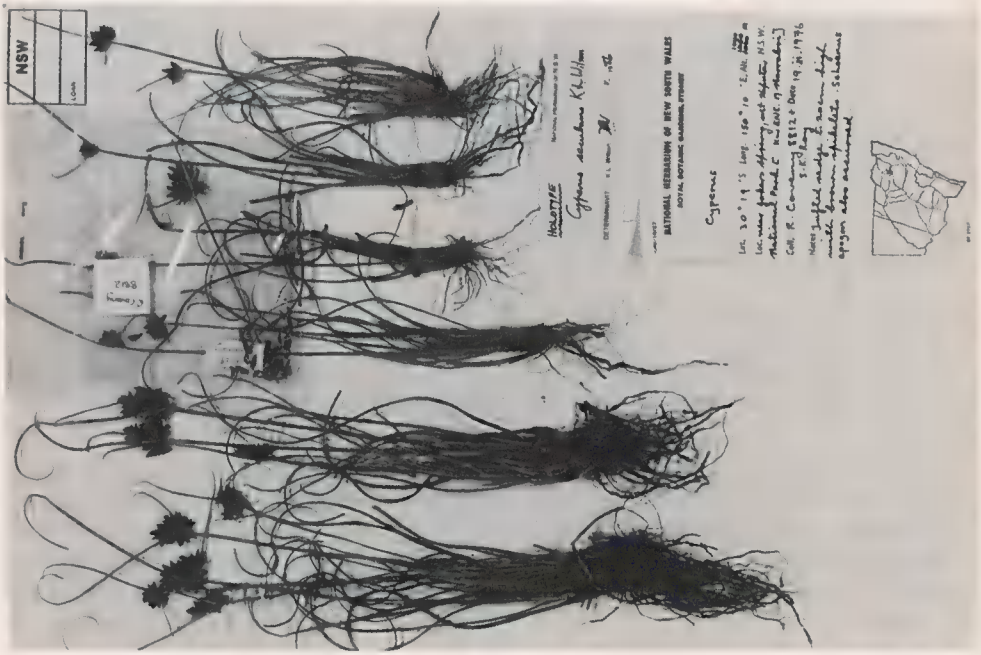
24. Cyperus centralis *K.L. Wilson*, **sp. nov.**

C. alternifloro et *C. lhotskyano* affinis; sed a *C. alternifloro* habitu graciliore, basibus subbulbosis, aculeis marginum foliorum sparsioribus brevioribusque, mucrone glumae recto, differt; a *C. lhotskyano* defectu rhizomatis, aculeis marginum foliorum plus-minusve regulariter antrorsis, saepe longioribus, differt.

Type: Northern Territory: Central South: Hull River, *P.K. Latz 4173*, 26 Aug 1973; holo NSW; iso K, NT, PERTH. Figure 27a.



a



b

Figure 27. Holotype of **a**, *C. centralis*; **b**, *C. secubans*.

[*C.* sp. aff. *cunninghamii* Wilson (1981a: 508, Figure 638G)]

Tall but slender perennial, tufted, often with rather long surculi and a thickened somewhat bulbous base, 40–110 cm high, not viscid. *Culms* trigonous to triquetrous, often slightly scabrous, 1–2.5 mm diam. *Leaves* flat to carinate or canaliculate, usually not septate-nodulose, < culms, to 3.5 mm wide; midrib ± obvious abaxially, usually smooth; marginal prickles dense to sparse, mostly regularly spaced (0.1–0.6(–1.1) mm apart), long to short, (0.05–)0.1–0.2 mm long, antrorse, aculeate; leaf sheaths usually not septate-nodulose, finely striate, not shining, stramineous above, purple-red below. *Inflorescence* simple or small-compound, 4–12 primary branches to 10 cm long; bracts suberect to spreading, 2–3 much exceeding the inflorescence. *Spikelets* c. 12 in loose, spicate to subdigitate, hemispherical clusters of 0.7–2.5 cm diam.; spikelets compressed, oblong to narrow-ovate, 5–13(–18) mm long, 1.5–3 mm wide in side view, 4–14(–18)-flowered; rachilla not thickened, not or narrowly winged, wings to 0.05 mm wide; glume spacing 1.1–2.3 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-elliptic to narrow-ovate, acute with straight mucro <0.1–0.3 mm long, stramineous to golden to red-brown with green midrib, 2.5–3.8 mm long, 0.5–1.0 mm wide, sides (1–)2–4-nerved, margins inrolled and narrow-membranous. *Anthers* 1.3–2.3 mm long excluding appendage ≤0.1(–0.2) mm long. *Nut* trigonous, very narrow-elliptic with acute apex, faces flat to convex, pale brown, shortly elongate-colliculate to foveate, glistening or shining, 1.7–2.2 mm long, ½ – ¾ length of glume, 0.3–0.7 mm diam., falling with glume. Figure 28a–c.

Distribution: Central Australia (Central North and South), and adjoining areas of Western Australia and South Australia. Figure 26b.

Habitat: Sandy soils; in the ranges, in seasonally wet situations (rockholes, gullies, stream banks and beds).

The epithet refers to the species' occurrence in the geographical centre of Australia; from the Latin *centralis*, in the middle or central.

C. centralis shows similarities to *C. alterniflorus* and the more mesic species *C. lhotskyanus*, but differs from both in the form of the marginal prickles on the leaves. *C. centralis* differs from *C. alterniflorus* in being more slender, with the prickles on the leaf margins sparser, less regular, shorter and more slender, and the leaf midrib not strongly scabrous on the lower surface. *C. alterniflorus* has glumes with a more obtuse apex and a more excurved mucro. *C. lhotskyanus* differs from *C. centralis* in being mostly shortly but distinctly rhizomatous, with bases that are distinctively coloured (dull purple-red below, whitish or stramineous above), and in having irregularly spaced mixed-type prickles on the leaf margins.

Specimens seen in various herbaria in the early stages of this study were labelled as *C. sp. aff. cunninghamii*. *C. centralis* can be distinguished from *C. cunninghamii* by the latter's viscidity, tufted habit, generally more slender and canaliculate leaves with longer marginal prickles, often terete spikelets, glume colour, and broadly winged rachilla.

C. centralis differs from *C. betchei* subsp. *commiscens* in its red-brown glumes (occasionally stramineous or golden with red-brown blotches), the often fewer-flowered spikelets, and the generally shorter spikelets and longer anthers. It also differs from *C. dactylotes* in glume colour, as well as in anther length, in its often relatively long surculi, its usually broader spikelets, and its greater glume spacing, glume length and nut length.

The relatively few specimens I have seen from Western Australia are generally more robust (e.g. *Carolin 5796*, *George 4581*). Plants found along streamlines from Oodnadatta to Charlotte Waters seem intermediate between this species and *C. alterniflorus*

(q.v.). Similarly, specimens from the northern part of the arid zone appear intermediate between this species and *C. carinatus* (q.v.).

SELECTED SPECIMENS (120 examined): NORTHERN TERRITORY: Central North: Mt Doreen Station, *Latz 2012*, Jan 1972 (NT, NSW); Wartupunya Rockhole, *Latz 2134*, Jan 1972 (NT, NSW); Central Mount Stuart, *Latz 5579*, July 1974 (NT, BRI, NSW). Central South: Valley of the Eagles, *Beauglehole 24364*, July 1967 (NSW, NT); George Gill Range, Carmichaels Crag, *Beauglehole 26245*, July 1968 (NT);

Figure 28. Spikelet details. *C. centralis*: **a**, spikelet; **b**, glume; **c**, nut. *C. secubans*: **d**, spikelet; **e**, glume; **f**, nut. *C. isabellinus*: **g**, spikelet; **h**, glume; **i**, nut. **a–c** from *Latz 2134*; **d–f** *Coveny 8879*; **g–i** *Wilson 4199*. a, d, g X 11; b, c, e, f, h, i X 14.

Standley Chasm, Heavitree Range, *Chippendale 522*, Nov 1954 (NT, BRI, CANB, MEL, NSW, PERTH), *McKee 8657*, Feb 1961 (BRI, CANB, K); Palm Valley, *Latz 1872*, Dec 1971 (NT), *Wilson 3883*, May 1981 (NSW); Kulgera, *Chippendale & Johnson*, Oct 1957 (NT 3977, AD, BRI, MEL, NSW, PERTH); Docker R, Petermann Ranges, *Chippendale*, June 1958 (NT 4562, AD, BRI, MEL, NSW, PERTH); summit of Ayers Rock, *Jackson 115*, Aug 1959 (AD), *Schodde 410*, Aug 1957 (AD, CANB, K); 26 miles [42 km] NE of Docker R. Settlement, *Latz 871*, Oct 1970 (NT, BRI, L); Fringe Lily Gorge, east Chewing Range, *Latz 9970*, Oct 1984 (NSW ex NT). South Australia: North-western: near Watarunya Rockhole, *Barker 3069*, Aug 1978 (AD); Everard Ranges, Everard Park, *Forde 911*, Sep 1957 (AD, BRI, NT); Everard Range, gorge N of Victory Well, *Eichler 17443*, Sep 1963 (AD, K); Cave Hill, N of Musgrave Range, *George 5176*, July 1963 (PERTH, BRI); Mt Lindsay, *Symon 2567*, Aug 1962 (AD, K, PERTH); Everard Range, Mt Carmeena, *Whibley 1176*, Sep 1963 (AD, NSW). Western Australia: Ashburton: 72 miles [116 km] N of Meekatharra, *George 3638*, Mar 1962 (PERTH). Giles: Giles Creek, S of Dean Range, *Carolin 6066*, Aug 1967 (SYD); Walter James Range, Bungabiddy Waterhole, *Carolin 6245*, Aug 1967 (SYD), *George 8312*, Oct 1966 (PERTH); Rawlinson Range, c. 4 miles [6 km] N of Giles, *Hill & Lothian 826*, July 1958 (AD, K).

25. Cyperus secubans *K.L. Wilson*, **sp. nov.**

C. rigidello affinis sed foliis crassioribus canaliculatisque, aculeis marginum foliorum, colore glumarum, antheris longioribus, differt.

Type: New South Wales: Northern Tablelands: near Jokers Spring, Mt Kaputar National Park, *R. Coveny 8812 & S. Roy*, 19 Nov 1976; holo NSW; iso BRI. Figure 27b.

Slender perennial, tufted with slightly bulbous bases, 15–25 cm high, usually somewhat viscid. *Culms* terete or slightly flattened, smooth or scabrous, 0.8–1.2 mm diam. *Leaves* canaliculate, thickened, usually curly, not septate-nodulose, ¾ as long as to equalling the culms, to 1.4 mm wide; midrib not obvious abaxially; marginal prickles sparse, regularly spaced (0.1–1.3 mm apart), short, 0.05–0.10 mm long, erect or flabellate, papillate, occasionally mixed with rather blunt antrorsely aculeate prickles; leaf sheaths not septate-nodulose, not smooth or shining, striate, pale brown with red-brown blotches. *Inflorescence* simple, densely clustered or with 1–3 primary branches to 4 cm long; bracts erect, usually curly, 1–2 exceeding the inflorescence. *Spikelets* 10–15 in small, dense to loose, subdigitate, globose clusters of 1.0–1.5 cm diam.; spikelets compressed, oblong, 7–9 mm long, 2.5–3.5 mm wide in side view, 4–8-flowered; rachilla not thickened, narrowly winged, wings to 0.05 mm wide; glume spacing 1.0–1.7 mm; spikelet falling as a unit or rachilla persistent and glumes falling individually. *Glumes* ovate to elliptic, retuse to broad-acute with straight mucro ≤0.1 mm long, red-brown to dark red-brown with a green midrib, 2.5–3.0 mm long, 0.8–1.2 mm wide, sides 3–4-nerved, margins narrow-hyaline and only slightly inrolled. *Anthers* 1.3–1.6 mm long excluding appendage 0.1 mm long. *Nut* trigonous, narrow-obovate to narrow-elliptic with acute apex, faces flat, pale to dark brown, colliculate to smooth and reticulate-areolate, shining, 1.6–2.1 mm long, ¾ – ⅞ as long as the glume, 0.6–0.8 mm diam., falling with glume. Figure 28d–f.

Distribution: Restricted to the Nandewar Range of New South Wales. Figure 26c.

Habitat: In rock crevices on rock shelves; often slightly swampy open sites at higher altitude, apparently associated with outcrops of volcanic origin.

The epithet is derived from the Latin *secubare*, to lie or sleep by oneself, hence by transference to live alone; in reference to the species' physical isolation from others of section *Pinnati*.

C. secubans shows morphological similarities to both *C. rigidellus* and *C. lhotskyanus*. It differs from *C. rigidellus* in having mixed-type prickles on the leaf margins, longer anthers, glumes more or less evenly dark red-brown, and with a straight mucro ≤0.1

mm long. It differs from *C. lhotskyanus* in the shorter, mixed prickles on its leaf margins, in its thickened, curly and canaliculate leaves and bracts without midrib, its shorter glume mucro, and its tufted habit.

C. fulvus also grows in the Nandewar Range but in drier habitats. It differs from *C. secubans* in its thinner-textured leaves with longer marginal prickles, its stramineous to golden-brown glumes with red-brown blotches and its shorter anthers.

Specimens examined: New South Wales: Northern Tablelands: *Coveny & Roy 8812* (NSW, BRI); 26 km ENE of Narrabri towards Dawsons Spring, *Coveny & Roy 8879*, Nov 1976 (NSW, BRI, K, P), *Coveny & Roy 8881*, Nov 1976 (NSW); Waa Gorge, Mt Kaputar National Park, *Coveny & Roy 9006*, Nov 1976 (NSW); 1–2 miles [3–5 km] W of Mt Kaputar, *Johnson & Constable*, Nov 1954 (NSW 30757); Mt Coryah, Mt Kaputar National Park, *Wilson 1334*, Oct 1975 (NSW), *Wilson 6995*, Nov 1986 (NSW, BRI, K); Mt Yulludunida, Mt Kaputar National Park, *Wilson 1348*, Oct 1975 (NSW).

26. Cyperus isabellinus *K.L. Wilson*, **sp. nov.**

C. rigidello affinis sed aculeis marginum foliorum, colore formaque glumarum, rhachilla alata, superficie nucis, differt.

Type: Queensland: Darling Downs: 6 km S of Yandilla–Tummaville road on Owens Scrub Road to Leyburn, *K.L. Wilson 4199*, 30 Dec 1981; holo NSW; iso BRI, CANB, K, L, NT, NY. Figure 29a.

Slender annual or short-lived perennial, tufted, shallow-rooted, 30–55 cm high, not viscid. *Culms* obscurely trigonous to subterete, rather soft (therefore compressed when pressed and dried), smooth, 1–2.5 mm diam. *Leaves* flat but keeled, usually septate-nodulose, ⅔ as long as to equalling culms, to 3.8 mm wide; midrib obvious abaxially, smooth or scabrous; marginal prickles dense to sparse, mostly regularly spaced (0.2–1.3 mm apart), short to long, 0.05–0.15 mm long, antrorse, aculeate; leaf sheaths septate-nodulose, not shining, stramineous with occasional dark red-purple blotches. *Inflorescence* simple or small-compound, 6–12 primary branches to 11.5 cm long; bracts erect to spreading, (2–)3–4 exceeding the inflorescence. *Spikelets* 6–15 in subdigitate, loose, hemispherical to globose clusters of 1–5 cm diam.; spikelets compressed, oblong, 6–22(–38) mm long, 2.0–2.5 mm wide in side view, 8–18(–38)-flowered; rachilla not thickened, narrowly to broadly winged, wings 0.05–0.2 mm wide; glume spacing 1.5–1.8 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* narrow-ovate to elliptic, acute with straight mucro 0.2–0.5 mm long, stramineous to golden-brown with very occasional red-brown blotches and green midrib, 2.7–3.4 mm long, 0.7–0.9 mm wide, sides 2–3-nerved, margins inrolled and narrow-membranous. *Anthers* 0.8–1.3 mm long excluding appendage <0.1 mm long. *Nut* trigonous, narrow-elliptic to narrow-obovate with acute apex, faces flat to convex, pale yellow-brown, colliculate to foveate, shining to glistening, 1.8–2.5 mm long, ⅞ as long as to equalling glume, 0.6–0.8 mm diam., falling with glume. Figure 28g–i.

Distribution: Only known from the North Kennedy, Leichhardt and Darling Downs regions of eastern Queensland. Figure 26c.

Habitat: Clayey soils; apparently restricted to gilgais ('melon-holes') in brigalow forest or around depressions or along drains in belah (*Casuarina cristata*) woodland.

The epithet refers to the yellowish glumes and is from the neo-Latin *isabellinus*, meaning tawny yellow (see Stearn (1973) and the Société française des Chrysanthémistes (1905) for the tale behind the meaning).

One specimen, *White 8887*, from near Townsville, differs from others in its nut surface, which resembles that of *C. fulvus* in being olive-brown rather than yellowish,

a

b

Figure 29. Holotype of **a**, *C. isabellinus*; **b**, *C. latzii*.

with smaller surface reticulations. Similarly, a specimen from Palardo (*Blake 5837*) exhibits a mixture of features that suggests it is a hybrid between these two species.

C. isabellinus is related to *C. rigidellus* but differs in the prickles on its leaf margins, in glume colour and shape, in the winged rachilla (also winged in one form of *C. rigidellus*) and in the nut surface, which has larger reticulations. Another related species is *C. clarus*, from which it differs in its marginal prickles, its narrower spikelets with winged rachilla and greater glume spacing, its straight glume mucro, and its nut shape, colour and surface reticulation. It differs from *C. betchei* in its much smaller, tufted habit, its broader spikelets, straight glume mucro, and broader nut with larger surface reticulations.

Specimens examined: Queensland: North Kennedy: between Campaspe R. and Victoria Creek, *Blake and Webb 1574B*, Apr 1945 (BRI, K, L); 26 miles [42 km] S of Charters Towers on Clermont road, *R.W. Johnson 1835*, May 1960 (BRI). Leichhardt: 8 km SE of Emerald, *Godwin*, May 1976 (BRI 216727); 15 km S of Emerald, *R.W. Johnson 1356*, Feb 1960 (BRI); Roundstone, *R.W. Johnson 1689*, May 1960 (BRI); Cottenham, c. 20 km NW of Banana, *R.W. Johnson 1715*, May 1960 (BRI). Port Curtis: Callide Valley, *White 10874*, Apr 1937 (BRI). Darling Downs: near Brigalow, *Blake 13308*, Feb 1938 (BRI); N of Jackson, 'Cypress Downs', *Blake 19155*, Mar 1953 (BRI, K, MEL, NSW); c. 10 miles [16 km] W of Meandarra, *R.W. Johnson 743*, Mar 1959 (BRI, CANB, K); Calala c. 10 miles [16 km] E of Meandarra, *R.W. Johnson 1611*, Apr 1960 (BRI); Chinchilla, *Lithgow 46*, Feb 1978 (BRI); The Deep, 16 miles [26 km] SSW of Tara, *McDonald 130*, Apr 1964 (BRI, CANB, K); 18 miles [29 km] N of Jackson, *Melville et al. 3444*, Mar 1953 (K, MEL, NSW, PERTH); c. 0.5 km S of Mulga Ridge, NW of Talwood, *Wilson 1862*, Mar 1978 (NSW); c. 2.5 km SE of Brigalow on Dalby road, *Wilson et al. 3348*, Apr 1981 (BRI, NSW, P); between Inglewood and Milmerran, *White 9680*, Jan 1934 (BRI, K).

27. Cyperus rigidellus *(Benth.) J. Black*

Black (1929: 676), (1943: 145), (1978: 261, Figure 233); Kükenthal (1935–36: 457); Blake (1940: 43); Blake (1943: 53); Blake in Eardley (1946: 157); Willis (1962: 218), (1970: 218); Wilson (1981a: 508); Cunningham et al. (1981: 162); Sharpe (1989: 324, Figure 47F). *C. gracilis* var. *rigidellus* Bentham (1878: 266), as 'var. ?rigidella', p.p. *Mariscus rigidellus* (Benth.) C.B. Clarke (1908: 18); Domin (1915: 445).

Type: South Australia: Lake Eyre, *Andrews 122*; lecto K (here designated).

Cyperus subpinnatus Kükenthal (1931: 199); Kükenthal (1935-36: 453, Figure 50A–F); Cunningham et al. (1981: 163). Type: New South Wales: Nyngan, *Baeuerlen 20*; lecto B (here designated); isolecto NSW, as *'Baeuerlen 2521*, xii.1899'.

Cyperus subpinnatus var. *subrigidellus* Kükenthal (1931: 200); Kükenthal (1935–36: 453). Type: South Australia: Tinga-tingana ('Lake Torrens Gebiet'), *Basedow*; lecto B (here designated), locality cited as 'Lake Torrens'.

[*C. enervis* auct. non R. Br.: Black (1922: 89)]

[*C. gracilis* auct. non R. Br.: Black (1922: 89); Ewart (1931: 215), p.p]

[*C. gilesii* auct. non Benth.: Moore & Betche (1893: 448)]

Slender annual or short-lived perennial, tufted, shallow-rooted, 6–30 cm high, occasionally viscid especially about the inflorescence. *Culms* triquetrous to terete, often scabrous at least near the apex, 0.6–1.3 mm diam. *Leaves* carinate to canaliculate, somewhat thickened, not septate-nodulose, shorter than to exceeding the culms, to 3 mm wide, usually curly at the apex; midrib occasionally obvious abaxially, smooth or scabrous; marginal prickles sparse to very sparse, irregularly spaced (0.3–2.6 mm apart), long to short, (0.05–)0.10–0.2 mm long, erect, papillate; leaf sheaths not septate-nodulose, smooth, not shining, pinkish to purple-red (stramineous near top). *Inflorescence*

simple, 1–4 primary branches 1–6 cm long; bracts mostly spreading but with at least one erect, tending to curl at the apex, 1–3 exceeding the inflorescence. *Spikelets* 5–15 in dense to loose, subdigitate, hemispherical to globose clusters of 1–3.0(–3.5) cm diam.; spikelets compressed, oblong, 4–20(–27) mm long, 2.5–4.0 mm wide in side view, 6–20(–36)-flowered, occasionally viscid; rachilla not thickened, narrowly or broadly winged, wings 0.05–0.15 mm wide; glume spacing 1.3–2.3 mm; spikelet falling as a

Figure 30. Spikelet details. Short- and long-glumed examples of *C. rigidellus*: **a, d**, spikelet; **b, e**, glume; **c, f**, nut. *C. clarus*: **g**, spikelet; **h**, glume; **i**, nut. **a–c** from *Latz 5016*; **d–f** *Briggs 4568*; **g–i** *Blake 5174*. a, d, g X 11; b, c, e, f, h, i X 14.

unit, or rachilla persistent and glumes falling individually. *Glumes* elliptic to narrow-ovate to ovate, with the green midrib often distinctly curved in side view, acute to obtuse, with straight to excurved mucro 0.1–0.4 mm long, stramineous with red-brown blotches or evenly red-brown, 1.8–3.5(–4.7) mm long, 0.7–1.0 mm wide, sides (1–)2–3-nerved, margins somewhat inrolled and narrow-hyaline. *Anthers* 0.3–1.2 mm long excluding appendage ≤0.1 mm. *Nut* trigonous, narrow-obovate to very narrow-elliptic with acute apex, faces concave to convex, pale brown, tuberculate or small-colliculate, glistening, 1.3–3.2 mm long, ¾ – ⅞ as long as the glume, 0.5–0.8 mm wide, falling with glume (only when spikelet is viscid). Figure 30a–f.

Distribution: Widespread in southern inland Australia, extending only slightly north of the Tropic of Capricorn. Figure 26d. Ryves (1976) may be referring to this species, which is widespread in wool-producing areas, when he records the tropical species *C. sporobolus* as being a wool-alien at Blackmoor, England.

Habitat: Sandy to clay-loam soils; in a wide range of ephemerally wet situations (creek or lake banks, floodways, waterholes, roadside drains, claypans, margins of saltpans).

C.B. Clarke effectively lectotypified Bentham's var. *rigidellus* as belonging to this species by citing *Andrews 121, 122* (the two are mounted on the one sheet in K). The other specimen cited by Bentham belongs to *C. fulvus*. However, a type can only be one collection, so *122* is here designated as lectotype since it bears Clarke's diagnostic notes.

The lectotype chosen for *C. subpinnatus* (on the basis that it was the only potential lectotype that could be found in B) was cited by Kükenthal as *'Bäuerlen 20'*. As with the many other specimens sent to him from NSW and the Technological Museum (now the Museum of Applied Arts and Sciences – its collections now in NSW), he cited only the number that was added to the duplicates and parent sheets when such duplicates were removed to be sent to him. The NSW duplicate of this type bears both Baeuerlen's number *2521* and the notation 'Sent to K. No. 20'.

C. rigidellus is a variable species, especially in glume and mucro length, rachilla wing width and plant size. This variation may warrant taxonomic recognition, but further collection and preferably growing of plants under controlled conditions is needed to assess this. The species is related to *C. gilesii* (q.v.), *C. clarus* (q.v.) and *C. secubans* (q.v.).

Selected specimens (151 examined): Queensland: Gregory North: Currawilla, c. 100 miles [160 km] W of Windorah, *Everist 3976*, June 1949 (BRI, CANB, K). Mitchell: 2 km E of Reedy Creek on Bowen Downs–Lake Galilee road, *Wilson et al. 3537*, May 1981 (NSW, BRI, H, K, P, UB). Darling Downs: c. 3 km W of Yelarbon on Goondiwindi road, *Wilson 1358*, Oct 1975 (NSW, BRI). Maranoa: Boatman Station, *Everist 2856*, Mar 1947 (BRI, CANB, K). Warrego: Dynevor Lakes, 30 miles [48 km] E of Thargomindah, *Blake 11762*, June 1936 (BRI, K, MEL). Gregory South: 136.6 km NW of Nocundra, *Boyland 3097*, July 1971 (BRI). New South Wales: North Western Plains: 'Iolanthe', c. 25 km SW of Garah, *Wilson 1466*, Apr 1976 (NSW, BRI, K, P, PH). South Western Plains: just W of Micabil Exclusion area, *Wilson 5656*, Nov 1983 (NSW, P). North Far Western Plains: 130 km W of Wanaaring on Milparinka road, *Blaxell 621*, Nov 1971 (NSW, AD, BRI, P). Victoria: A: Kings Billabong, southern end, *Browne 77*, Jan 1982 (NSW). C: Lake Hindmarsh, *Reader*, Apr 1895 (BRI, BM, EDIN). F: Lake Carpel, c. 19 km SE of Robinvale P.O., *Beauglehole 56179*, May 1977 (MEL, AD, NSW). Northern Territory: Central North: Napperby Station, *Latz 1962*, Jan 1972 (NT, AD, CANB, NSW, PERTH). Central South: Mulga Park Station, *Latz 5016*, Apr 1974 (NT, AD, BRI, NSW). South Australia: North-western: c. 6 km WSW of Dingo Flat Gate, *Lay 778*, Apr 1973 (AD). Lake Eyre: Federal Swamp, Mount Dare Station, *Latz 4805*, Apr 1974 (NT, AD, NSW). Gairdner-Torrens: Oakden Hills, W of Lake Torrens, *Murray 540*, Apr 1930 (AD). Flinders Ranges: Mt Parry Gap, *Murray*, 1882 (AD 97609529). Eastern: c. 10 km W of Quinyambie HS., *Whibley 3566*, July 1971 (AD). Eyre Peninsula: head of Spence Gulf, N of Port

Augusta, *Adams in hb. Black*, May 1921 (AD 97519321). Murray: Murray R. floodplain opposite Lyrup, *Eichler 13763*, Apr 1957 (AD). WESTERN AUSTRALIA: Mueller: just W of W.A.–N.T. border in 23°10′ S, *George 8926*, July 1967 (PERTH, CANB). Fortescue: 16 miles [26 km] from Onslow, Roebourne road, *Carolin 7836*, Aug 1970 (SYD, NSW). Carnarvon: 19 km S of Yannarie R., 170 km S of Onslow, *Beauglehole 11645*, Aug 1965 (NSW, NT, PERTH). Ashburton: 3 km E of Pell Creek, *Cranfield 2020*, Apr 1982 (PERTH). Austin: c. 22 miles [35 km] S of Mt Magnet, *George 724*, Apr 1960 (PERTH, BRI). Irwin: Geraldton, *Gerstone 226*, Nov 1963 (PERTH).

28. Cyperus clarus *S.T. Blake*

Blake (1940: 44), p.p. max.; Black (1943: 145), as to descr. only; Wilson 1987: 1136, Figure 484B; Sharpe (1989: 326, Figure 47K).

TYPE: QUEENSLAND: Darling Downs: Drayton, *S.T. Blake 5174*, 12 Feb 1934; holo BRI; iso K, MEL, NSW.

Slender annual or perennial, tufted, 20–90 cm high, not viscid. *Culms* triquetrous to trigonous, smooth or scabrous at apex, 1–2.5 mm diam. *Leaves* flat or carinate, relatively thin-textured, somewhat septate-nodulose, ½ – ¾ as long as culms, to 6 mm wide, bright yellow-green; midrib obvious abaxially, smooth or scabrous towards apex; marginal prickles sparse to dense, irregularly spaced (0.3–1.4 mm apart), short

Figure 31. Distribution of: **a**, *C. clarus*; **b**, *C. fulvus* (New Guinea occurrence not mapped); **c**, *C. perangustus*; **d**, *C. gilesii* (crosses) and *C. latzii* (open circles).

to long, 0.05–0.20 mm long, erect to antrorse and retrorse, occasionally flabellate, aculeate or rarely papillate; leaf sheaths ± septate-nodulose, not smooth or shining, chestnut-brown. *Inflorescence* simple, 3–6 primary branches to 9.5 cm long; bracts erect when young, spreading nearly horizontally when mature, (1–)2–3 exceeding the inflorescence. *Spikelets* numerous in ± dense subdigitate, ± globose clusters of 1.5–3.5 cm diam.; spikelets compressed, oblong to narrow-ovate, 7–18 mm long, 3.0–4.5 mm wide in side view, 8–14(–20)-flowered; rachilla not thickened, not to broadly winged, wings to 0.1 mm wide; glume spacing 1.2–1.5 mm; spikelet with rachilla persistent, glumes falling individually. *Glumes* elliptic or ovate, acute with excurved to ± straight mucro 0.3–0.8 mm long, golden-brown to brown when old and dry, with green midrib, 2.5–4.0 mm long, 0.6–1.0 mm wide, sides 3–4-nerved, margins slightly inrolled and membranous. *Anthers* 0.3–1.1 mm long excluding appendage <0.1 mm long. *Nut* trigonous, obovate with ± obtuse to broad-acute apex, faces concave to flat, grey to nearly black (epidermal cells whitish over black body of nut), tuberculate, dull to glistening, 1.6–1.9 mm long, ½ – ⅔ as long as glume, 0.6–0.8 mm wide, falling with glume or separately. Figure 30g–i.

Distribution: Central and south-eastern Queensland, extending to near Inverell on the North Western Slopes of New South Wales. Figure 31a. Ryves (1976) lists this as a wool-alien at Blackmoor Fruit Farm, N Hants., England.

Habitat: Apparently restricted to heavy soils derived from basalt; in grassland or open woodlands.

Blake's original description of *C. clarus* included immature specimens of *C. alterniflorus* with yellowish glumes (from Goyinga Mountains, Mootwingie and Oodnadatta).

C. clarus is most closely related to *C. fulvus*, with which it occasionally grows, differing in its generally broader spikelets and larger glumes, which are more evenly coloured yellow to dark golden-brown, in its nut surface and colour, and in its longer excurved glume mucro (although specimens of *C. fulvus* from northwestern Queensland have the mucro to 0.5 mm long). The leaves of *C. clarus* are darker (R.H.S. colour 144) and softer-textured than those of *C. fulvus* (R.H.S. colour 143). *C. clarus* also has some similarity to *C. isabellinus* (q.v.), but grows in a different habitat and shows various differences morphologically. *C. clarus* differs from *C. gilesii* and *C. rigidellus* in glume and nut shape, and in the prickles on the leaf and bract margins.

Selected specimens (25 examined): Queensland: Leichhardt: Minerva, N of Springsure, *Blake 7934*, Mar 1935 (BRI, K, MEL, NSW); Sandy Creek, c. 1.5 km S of Banana on Theodore road, *Wilson et al. 3630*, May 1981 (NSW). Burnett: Brian Pastures Experiment Station, -, May 1958 (BRI 9290). Darling Downs: Palardo, W of Miles, *Blake 5886*, May 1934 (BRI, CANB, MEL, NSW); 30 km SSE Toowoomba New England Highway, *Latz 4590*, Feb 1974 (NT); 4 km S of East Greenmount on Warwick–Toowoomba road, *Wilson 4176*, Dec 1981 (NSW, BRI, H, K, P); 8.5 km WSW of Westbrook on Pittsworth road, *Wilson 4183*, Dec 1981 (NSW). Maranoa: Mitchell, Maranoa R., *Blake 5738*, May 1934 (BRI, MEL). Warrego: Morven, *Blake 11008*, Apr 1936 (BRI, K, MEL, NSW, P). New South Wales: North Western Slopes: Delungra, *Gidley NSW 65097*, Jan 1962 (NSW); 2.6 km W of Graman-Oakwood road on Cherry Tree Hill – Delungra road, *Wilson 4323*, Jan 1982 (NSW); c. 4.5 km NE of Delungra on Graman road, *Wilson 4326*, Jan 1982 (NSW, P); 2 km S of Oakwood at Mt Russell turn-off, *Wilson 6228*, May 1985 (NSW); 2 km N of Bukkulla on Ashford road, *Wilson 6218*, May 1985 (NSW, BRI, NE, P).

29. Cyperus fulvus *R. Br.*

Brown (1810: 215); Poiret (1817: 187); Sprengel (1824: 226); Kunth (1837: 111); Steudel (1854: 53); Mueller (1874: 268), p.p.; Bentham (1878: 274), p.p. max.; Moore & Betche (1893: 448); Bailey (1902: 1742); Kükenthal (1935-36: 456), p.p.; Kern (1974: 638); Cunningham et al. (1981: 160); Beadle et al. (1982: 606); Wilson (1987: 1136); Sharpe (1989:

326, Figure 47L). *Mariscus fulvus* (R. Br.) C.B. Clarke (1908: 18); Clarke (1909: pl.30, Figure 7–8); Domin (1915: 443), p.p. max.

TYPE: QUEENSLAND: East Coast, *R. Brown (Bennett 5905)*; lecto BM (here designated); isolecto BM, BRI (fragm.).

Mariscus fulvus var. *canescens* C.B. Clarke ex Domin (1915: 444). *C. fulvus* var. *canescens* (Domin) Kükenthal (1935–36: 456). TYPE: QUEENSLAND: Kings Creek, *Bowman*, 1870; lecto K (here designated); probable isolecto BM, BRI, K, MEL.

Mariscus fulvus var. *confusus* C.B. Clarke ex Domin (1915: 444). *C. fulvus* var. *confusus* (Domin) Kük. (1935–36: 456); Blake (1954: 237). TYPE: QUEENSLAND: Gracemere, *O'Shanesy*; lecto K (here designated; mounted on same sheet as 'Richmond River, *Dangar*' and 'near Tenterfield, *Stuart*'); isolecto BRI.

Mariscus fulvus var. *densispiculatus* Domin (1915: 444). *C. fulvus* var. *densispiculatus* (Domin) Kükenthal (1935–36: 457). TYPE: QUEENSLAND: Pentland, *Domin*; holo PR, n.v.

C. fulvus var. *viscidus* Kükenthal (1935–36: 456). TYPE: NEW SOUTH WALES: Warrumbungle Ranges, *Forsyth*; lecto NSW 22703, sent to Kükenthal as 'No. 73' (here designated); isolecto BRI.

C. gracilis R. Br. var. *rigidellus* Bentham (1878: 266), as '?rigidella', p.p. ('head of Boyd River, *Leichhardt*', MEL 92161).

C. laetus C.B. Clarke (1908: 9); Domin (1915: 435); nec Presl (1828) nec Kunth (1837) nec Ridley (1884). TYPE: QUEENSLAND: Gracemere, *O'Shanesy*; lecto K (here designated); isolecto BRI, ?MEL.

Mariscus fulvus var. *jucundus* Domin (1915: 444). TYPE: QUEENSLAND: Gracemere, *O'Shanesy*; holo K; iso BRI, MEL. [Same type as *C. laetus* C.B. Clarke]

C. ochroleucus Boeckeler (1875: 85); Kükenthal (1935–36: 481); Blake (1940: 43). TYPE: QUEENSLAND: Lake Elphinstone, *Dietrich s.n.*; holo B, as *'Dietrich 591'* fide Blake; n.v.

C. sieberi Kunth (1837: 96); Steudel (1854: 51); Boeckeler (1868: 608), (1875: 84); Clarke (1884: 142). TYPE: NEW SOUTH WALES: Nova Hollandia, *Sieber 630*; holo B, ex hb. Kunth; iso B, G, L.

[*C. alterniflorus* auct. non R. Br.: Bentham (1878: 275), p.p. min.; Bailey (1902: 1742), p.p.; (*O'Shanesy*, Gracemere).]

[*C. carinatus* auct. non R. Br.: Bentham (1878: 274), p.p. (Queensland and New South Wales specimens); Moore & Betche (1893: 448), p.p.; Bailey (1902: 1742), p.p.]

Slender perennial, tufted with bases sometimes subbulbously thickened, 25–50(-80) cm high, occasionally viscid. *Culms* trigonous or triquetrous (at least above), often terete below, smooth or scabrous, 0.9–2.5 mm diam. *Leaves* flat or carinate, often somewhat thickened, straight or somewhat curly, usually septate-nodulose, ⅔ the length of to slightly exceeding the culms, to 6(–9.5) mm wide, dull yellow-green; midrib ± obvious abaxially, smooth or scabrous; marginal prickles dense to very sparse, mostly irregularly spaced (0.1–2.0 mm apart), long to short, 0.05–0.25(–0.7) mm long, strongly flabellate to erect aculeate (and then margins often with very short scabrosities as well), or antrorsely aculeate; leaf sheaths not septate-nodulose, not smooth or shining, yellowish or stramineous with occasional red-brown blotches. *Inflorescence* simple or small-compound, 3–8(–10) primary branches to 7(–10) cm long; bracts erect to spreading, (1–)2–3(–6) exceeding the inflorescence. *Spikelets* 10->15 in dense, spicate, hemispherical to globose clusters of 1.5–3(–4) cm diam.; spikelets compressed, oblong, 6–15(–30) mm long, 2.0–3.5 mm wide in side view, 8–20(–36)-flowered; rachilla not thickened, not to broadly winged, wings to 0.2 mm wide; glume spacing 1.2–1.8(–2.0) mm; spikelet with rachilla persistent and glumes falling individually.

Glumes elliptic, broad-acute with straight mucro 0.1–0.3(–0.5) mm long, stramineous or golden-brown with dull red-brown blotches and a green midrib, 2.0–3.0 mm long, 0.6–0.9(–1.3) mm wide, sides 2–4-nerved, margins inrolled and hyaline to membranous. *Anthers* 0.5–1.2 mm long excluding appendage ≤0.1 mm long. *Nut* trigonous (generally with the angles very rounded), obovate to broad-elliptic with broad-acute apex, faces convex to flat, yellow-brown, colliculate to smooth and reticulate-areolate, shining, 1.5–2.0 mm long, ⅞ as long as to equalling the glume, 0.6–0.9 mm diam., falling with glume. Figure 32a–c.

Figure 32. Spikelet details. *C. fulvus*: **a**, spikelet; **b**, glume; **c**, nut. *C. perangustus*: **d**, spikelet; **e**, glume; **f**, nut. *C. gilesii*: **g**, spikelet; **h**, glume; **i**, nut. *C. latzii*: **j**, spikelet; **k**, glume; **l**, nut. **a–c** from *Coveny* 2475; **d–f** *Blake* 11304; **g—i** *Mills & Cox* 23; **j-l** *Dunlop* 3549. a, d, g, j X 11; b, c, e, f, h, i, k, l X 14.

DISTRIBUTION: Widespread in Queensland and New South Wales; also in southern New Guinea. Figure 31b. Probst (1949) lists this species as a wool-alien at Derendingen, Switzerland, in 1930. Ryves (1976) may be referring to this species when he records the tropical species *C. sporobolus* as a wool-alien at Blackmoor, England.

HABITAT: Sandy to loam soils; generally in open woodland or forest, often associated with a grassy understorey, over a wide latitudinal range (dominant tree species in the various regions include *Eucalyptus melanophloia*, *E. polycarpa* s.lat., *E. populnea*, *E. maculata*, *E. tereticornis*, *E. crebra*, *Callitris glaucophylla* and *Angophora leiocarpa*). Occasionally on coastal cliffs, in inland rocky gullies, along drainage lines around rock outcrops. On sandy riverbanks or in floodways in NW Queensland (and very occasionally so in other regions).

C. fulvus is a variable species, as will be seen from previous attempts to recognise varieties. However, the variation does not fall into clear patterns and is not recognisable taxonomically (on current knowledge). For example, strongly viscid specimens tend to have large, flabellate marginal prickles on the leaves and are generally slender plants, but these features are also seen (not united) in other non-viscid specimens. As Blake (1940) wrote, about var. *densispiculatus*: 'The taxonomic value of this variety is questionable, as in most tufts seen with reflexed secondary rays in the inflorescence, some inflorescences occur without such rays. In other words, *C. fulvus* (typical) and var. *densispiculatus* may occur on the same plant. The species is an exceedingly variable one!'

Specimens from north-western Queensland tend to have broader rachilla wings (to 0.2 mm wide), narrower glumes with more acute apex and a longer mucro (0.2–0.5 mm long) and a nut that is often much shorter relative to the glume. This form grows in seasonally wet situations, on banks of streams and waterholes. It would be possible to recognise this form as a subspecies, but it is undesirable to do so since it would leave a heterogeneous residue.

C. fulvus is closely related to *C. clarus* (q.v.) and *C. perangustus* (q.v.). It differs from *C. gilesii* in the shape and size of the glumes and nuts and also in the prickles on the leaf margins. There is a superficial resemblance between *C. fulvus* and depauperate specimens of *C. carinatus* (q.v.). Similarly, very large specimens of *C. fulvus* have been mistaken for *C. alterniflorus*, but the two species differ in most characters if one compares descriptions. The leaves of *C. fulvus* are more blue-green than those of *C. alterniflorus*. *O'Shanesy 1698, 1699* (MEL 92162, 92155) are very robust plants that could be confused with *C. alterniflorus*, but the nut and marginal prickles are typical for *C. fulvus*.

The name *C. fulvus* was applied rather indiscriminately in the past. Thus, Mueller & Tate (1890) and Mueller in Tate (1896) named a specimen of *C. betchei* subsp. *commiscens* as this ('*Tietkens*, Glen Helen'). Similarly, Fitzgerald (1918) used *C. fulvus* for a specimen of *C. ixiocarpus*; several other specimens ('*Fitzgerald*, Lennard, May and Fitzroy Rivers') listed under that name in that publication have not been seen. A few specimens listed under *C. fulvus* by Kükenthal (1935-36) have not been seen by me ('*Kempe 459*, Finke River; *Giles*, zwischen Youldeh und Elizabeth; *C.W. Nyalasy*, Kimberley-Distrikt'). These are all unlikely to be this species (unless the localities have been stated wrongly).

SELECTED SPECIMENS (280 examined): QUEENSLAND: Cook: Brooklyn Station, *Flecker 7288*, Feb 1941 (CANB). Burke: Mt Emu Plains Station, *Hubbard & Winders 7542*, Feb 1931 (K, BRI); Little Creek, 19 km NW of Riversleigh HS., *Wilson 5545*, May 1983 (NSW, BRI). North Kennedy: 20 miles [32 km] N of Conjuboy Station, *Lazarides 4199*, Feb 1954 (CANB, AD, BRI, K, MEL, NSW, NT, PERTH). South Kennedy: 3 miles [5 km] NE of Cerito Station, *Adams 966*, May 1964 (CANB, BRI, K). Gregory North: 22 km N of Wills Creek on Mt Isa road, *Wilson 5457*, May 1983 (NSW).

Mitchell: 10 km E of Birkhead, *Boyland 7016*, Mar 1974 (BRI, NSW, NT). Leichhardt: Sandy Creek, c. 1.5 km S of Banana, *Wilson et al. 3632*, May 1981 (NSW). Port Curtis: near Rockhampton, Mt Beserker, *Blake 12723*, Mar 1937 (BRI, CANB, K, NSW). Wide Bay: Wonbah turn-off, 15.5 km NE of Mt Perry, *Wilson & Sharpe 3757*, May 1981 (NSW, BRI). Burnett: Narayan, *Pedersen N185*, Apr 1972 (BRI); just outside boundary of Wuruma Dam, *Wilson & Sharpe 3744*, May 1981 (BRI, H, K, NSW, P). Moreton: Petrie, *Blake 1447*, Jan 1933 (K, MEL, NSW). Darling Downs: near Gurulmundi, near Wandoan, *Hubbard 5144*, Nov 1930 (K, BRI). Maranoa: SE of Surat, Thomby Range, *Blake 21301*, May 1960 (BRI, K, NSW). Warrego: Charleville, *Blake 5322*, Apr 1934 (BRI, NSW, NT). New South Wales: North Coast: Bundjalung National Park, 3 km N of Black Rocks, *Griffith NE B9*, May 1982 (NSW). Central Coast: junction of Jocks Creek and Wollondilly R., *Coveny et al. 6080*, Mar 1975 (NSW, BRI, CHR, K, P). Northern Tablelands: Chandlers Peak, Guyra, *Boorman*, Mar 1917 (NSW 22705, BM, BRI, K). Central Tablelands: Jenolan Caves district, *Blakely*, 1900 (NSW 22702, BRI, K). North Western Slopes: 9 km N of Baradine on Kenebri road, *Payne & Jacobs 1*, Jan 1976 (NSW, BRI, K, L, P, US). Central Western Slopes: 12.7 km WNW of Scone P.O. on Bunnan road, *Coveny et al. 5884*, Nov 1974 (NSW, BRI, CHR, K, L, P, TNS, US). North Western Plains: 2 km SW of Jomara, 4 km NE of Boora, *Wilson 1770*, Mar 1978 (NSW, BRI, CHR, K, L, P). South Western Plains: Warranary Hills, c. 5 km direct WNW of Roto, *Wilson & Murray 5893*, Mar 1984 (NSW, AD, MEL, P). North Far Western Plains: Mootwingee, between camping area and Snake Cave, *Briggs 2751*, May 1969 (NSW). New Guinea: Papua New Guinea: Quaipo [Kuaipo], *McGregor*, 1889 (MEL).

30. Cyperus perangustus *S.T. Blake*
Blake (1940: 43), authors given as '(Kükenth.) S.T. Blake'; Sharpe (1989: 324, Figure 47G).

Type: Queensland: Wide Bay: near Bundaberg, *S.T. Blake 11304*, 26 Apr 1936; holo BRI; iso K, MEL, NSW.

[*C. angustatus* auct. non R. Br.: Bentham (1878: 282), p.p.; Bailey (1902: 1746), p.p.; Kükenthal (1935-36: 452), p.p. *Mariscus angustatus* auct. non (R. Br.) C.B. Clarke: Domin (1915: 444), p.p. (*Bowman* and *O'Shanesy* specimens)]

Slender perennial, tufted, 45–95 cm high, spikelets occasionally somewhat viscid. *Culms* triquetrous to trigonous, usually strongly antrorsely scabrous above, 1–2.5 mm diam. *Leaves* flat or carinate, septate-nodulose, ½ – ⅔ as long as culms, to 4.5 mm wide; midrib obvious abaxially, scabrous; leaf margins dense or occasionally sparse, regularly spaced (0.1–0.6 mm apart), long to short, 0.1–0.2 mm long, strongly antrorse, aculeate; leaf sheaths ± septate-nodulose, not smooth and shining, stramineous. *Inflorescence* small-compound, 4–7(–11) primary branches to 8 cm long; bracts erect to spreading, 2–3(–5) exceeding the inflorescence. *Spikelets* few (c. 4–10) in obviously spicate, hemispherical to short-cylindrical clusters of 1.5–3 cm diam.; spikelets compressed, oblong, 5–18 mm long, 1.5–2 mm wide in side view, 4–16(–22)-flowered, occasionally somewhat viscid; rachilla not thickened, not to broadly winged, wings to 0.1 mm long; glume spacing 1.4–1.7 mm; spikelet falling as a unit, or rachilla persistent and glumes falling individually. *Glumes* elliptic, acute, with straight mucro <0.1–0.2 mm long, dark golden-brown, with a narrow green midrib, 1.7–2.2(–2.6: *Dallachy 261*) mm long, 0.5–0.7 mm wide, sides 2–3(–4)-nerved, margins very narrow-membranous and not or only slightly inrolled. *Anthers* 0.3–0.7 mm long excluding appendage <0.1 mm long. *Nut* trigonous, narrow-obovate with broad-acute to obtuse apex, faces flat to convex, pale red-brown, small-colliculate or foveate or smooth and reticulate-areolate, glistening to shining, 1.3–1.5 mm long, ⅞ as long as to equal to glume, 0.5–0.6 mm diam., falling with glume or separately. Figure 32d–f.

Distribution: Eastern coast of Queensland, from Townsville to Rockhampton. Figure 31c.

Habitat: Loamy or sandy soils; open forest or woodland sites near coast.

In publishing this species, Blake (1940) wrote that Kükenthal mentioned in correspondence that he thought this taxon could be treated as '*C. fulvus* R. Br. var. *perangustus* Kük.' However, Kükenthal did not actually publish this variety, so the author of the species should be given as just 'S.T. Blake'.

C. perangustus is closely related to *C. fulvus* but can be distinguished by its leaf margins, its more slender spikelets and glumes, and the nut shape and colour. These two species have their spikelets in more obviously spicate clusters than most other species. The leafy bracts subtending the ultimate branches of the inflorescence in *C. perangustus* are no longer than in *C. fulvus* (or indeed in most other species) but they appear more obvious because of the slender spikelets and the persistence of the bracts after the spikelets fall.

In the past, specimens of this species were sometimes labelled as *C. angustatus* (for example, '*Bowman*, Kings Creek' (K) was so-labelled by Bentham), but that species is rhizomatous. It differs further in the leaves, which have the midrib not obvious abaxially, and sparse and irregularly spaced marginal prickles, and in the subdigitate spikelet clusters.

Dallachy 261 from Rockhampton differs from other specimens in having completely smooth culms and large glumes c. 2.6 mm long.

SELECTED SPECIMENS (24 examined): QUEENSLAND: Cook: Barrabas Scrub, *Dockrill 526*, May 1972 (BRI). North Kennedy: Magnetic I. near Townsville, *Blake 8237*, Mar 1935 (BRI, MEL), *Blake 8249*, Mar 1935 (BRI, K, NSW); Townsville, Castle Hill, *Blake 8359*, Mar 1935 (BRI, K); James Cook University, Douglas Campus, Townsville, *Seary and Graham S-5296*, (JCT); Shelley Beach, Townsville, *Wells S-3967*, Feb 1971 (JCT). Port Curtis: Marmor, between Rockhampton and Gladstone, *Blake 12778*, Mar 1937 (BRI, MEL, NSW); Rockhampton, on W side of river, *Dallachy 261*, Jan 1863 (MEL, BRI); Pine Islet, Northumberland Group, *Heatwole*, Feb 1971 (BRI 146121); near Bluff Rock, Middle Percy I., *Lazarides 5658*, Apr 1956 (BRI, CANB, K); Beecher near Gladstone, *McLachlan 14*, May 1933 (BRI); Gracemere, *O'Shanesy 1414*, Nov 1873 (MEL), *O'Shanesy 1642*, Feb 1879 (MEL); Yeppoon, 40 km NE of Rockhampton, *Sharpe 2360*, June 1978 (BRI, NSW), *Wilson et al. 3670*, May 1981 (NSW, BRI, P). Wide Bay: Imbil, *Blake 14616*, June 1942 (BRI); North Aramara, *Blake 19259*, Mar 1954 (BRI, NSW).

31. Cyperus gilesii *Benth.*

Bentham (1878: 274); Tate (1890: 181); Bailey (1902: 1741); Domin (1915: 430); Ewart & Davies (1917: 55); Black (1922: 89), (1943: 145), (1978: 263); Kükenthal (1935–36: 453); Wilson (1981a: 507, Figure 638E); Cunningham et al. (1981: 160).

TYPE: NORTHERN TERRITORY: Charlotte Waters, *E. Giles*; lecto K (here designated); isolecto MEL (as 'Giles 20').

Slender annual or short-lived perennial, tufted, shallow-rooted, 10–35(–50) cm high, not viscid. *Culms* trigonous or triquetrous, smooth, 0.8–2 mm diam. *Leaves* flat or carinate, ± septate-nodulose, c. ½ as long as the culms, to 4.5 mm wide; midrib obvious abaxially, smooth or scabrous towards apex; marginal prickles sparse, irregularly or regularly spaced (0.2–0.8 mm apart), short, 0.05–0.10 mm long, erect, papillate or rarely aculeate; leaf sheaths not septate-nodulose, smooth, ± shining, salmon-pink, at base the margins white-membranous. *Inflorescence* simple, 1–5 primary branches to 6.5 cm long; bracts erect to spreading or deflexed, usually not septate-nodulose, 1–3 exceeding the inflorescence. *Spikelets* usually numerous in subdigitate, ± dense, hemispherical to globose clusters of 1.5–5 cm diam.; spikelets compressed, oblong, 10–30 mm long, 2.5–4.5 mm wide in side view, 8–34-flowered; rachilla not thickened, not to broadly winged, wings to 0.1 mm wide; glume spacing 1.0–1.5 mm; spikelet falling as a unit, or rachilla persistent and glumes falling

invididually. *Glumes* very narrow-elliptic to narrow-ovate, retuse or acute with usually excurved mucro 0.3–1.0 mm long, golden-brown to red-brown with green midrib, 3.0–5.0 mm long, 0.5–0.8 mm wide, sides 2–3-nerved, margins inrolled and narrow-membranous. *Anthers* 0.3–0.6 mm long excluding appendage <0.1 mm long. *Nut* trigonous, very narrow-elliptic with acute to acuminate apex, faces flat, red-brown to grey-brown (epidermal cells whitish over black body of nut), tuberculate to smooth and reticulate-areolate, glistening, 2.0–2.5 mm long, ⅔ – ¾ as long as glume, 0.3–0.5 mm diam., falling with glume. Figure 32g–i.

Distribution: Scattered in Central Australia, Queensland, NW New South Wales, and South Australia. Figure 31d. Probst (1949) records this species as a wool-alien at Derendingen, Switzerland, in 1915 and 1917.

Habitat: Sandy loam to clay soils; in ephemerally wet situtations (banks of creeks and waterholes, gilgais, on claypans, depressions in grassland, roadside drains).

The lectotype is immature, whereas the other specimen cited by Bentham (Mitchell district, *herb. Mueller*, –, MEL) has mature nuts in the spikelets. However, Bentham's script appears only on the Giles specimen (K) and this is therefore chosen as the lectotype since it is the only specimen definitely seen by Bentham.

C. gilesii is distinctive in its combination of the following characters: more or less oblong glumes with a generally long excurved mucro, papillate leaf margins, and long narrow nut. It shows some similarity to *C. clarus* (q.v.) and to *C. fulvus* (q.v.). It has papillate (or occasionally aculeate) leaf marginal prickles similar to those of *C. rigidellus* but it can be distinguished from that species by its nut and glume shape, its smooth culms, and its leaves and bracts, which are softer in texture and less curly.

Koch 494 (B), which belongs here, was cited by Kükenthal under *C. dactylotes*.

Selected specimens (84 examined): Queensland: Cook: Spring Creek, *Simonett*, July 1950 (BRI). Burke: Chudleigh Park Station 110 miles [175 km] N of Hughenden, *Hubbard & Winders 7642*, Feb 1931 (K, BRI). North Kennedy: 11 miles [18 km] E of Lolworth on Amara road, *Carolin 8415*, Apr 1974 (SYD). South Kennedy: 1 mile [1.5 km] E of Dooruna Station, *Adams 1256*, Aug 1964 (CANB, BRI). Gregory North: Pigeon Creek, 50 km NW of Dajarra on Mt Isa road, *Wilson 5473*, May 1983 (NSW, BRI). Mitchell: Prairie, *Hubbard & Winders 7090*, Feb 1931 (K, BRI, G). Leichhardt: 1 km ESE of Nogoa R. at Emerald on Capricorn Highway, *Wilson et al. 3594*, May 1981 (NSW, BRI, H, K, P). Warrego: Gilruth Plains, Cunnamulla, *Allen 596*, Mar 1947 (CANB, NE), *McKee 10288*, Apr 1963 (BRI, NSW). Gregory South: 7 km E of Toona Gate towards Warri Gate, *Wilson & Pickard 1664*, Nov 1976 (NSW, BRI, K, P). New South Wales: North Western Plains: 25 miles [40 km] N of Bourke on N Collerina road, *Milthorpe & Cunningham 1725*, Mar 1974 (NSW, P). North Far Western Plains: 12 km S of Warri Gate on Tibooburra road, *Briggs & Seur 5409*, Sep 1974 (NSW, BRI, K). Northern Territory: Barkly Tableland: 7 miles [11 km] W Armchair Bore, Brunette Downs, *Chippendale 1972*, Mar 1956 (NT, AD, BRI, CANB, MEL, NSW, PERTH). Central North: MacDonald Downs, *Latz 5816*, Oct 1974 (NT, BRI, NSW). Central South: Yambah Station, Burt Plain, *Latz 5955*, May 1975 (NT); Andado Station, *Latz 6779*, Apr 1977 (NT, AD, BRI, K). South Australia: Flinders Ranges: Mt Lyndhurst, *Koch 494*, Mar 1900 (B, DBN, K, NSW). Gairdner-Torrens: c. 17 km N of Bosworth Station HS., Lake Torrens, *Swinbourne 114*, Sep 1968 (AD). Lake Eyre: 13 km N of Wintinna Creek, *Beauglehole 44392*, May 1974 (NSW, NT); 5 miles [8 km] N of Cordillo Downs, *Filson 3395*, Oct 1960 (AD, NSW).

32. Cyperus latzii *K.L. Wilson*, **sp. nov.**

Ab speciebus aliis Sectionis Pinnatorum glumis latiore carinatis patentibusque differt.

Type: Northen Territory: Victoria River: Armstrong River crossing, Wave Hill–Top Springs road, *K.L. Wilson 4741*, 21 Apr 1983; holo NSW; iso BRI, CANB, K, L, NT, NY, P, PERTH. Figure 29b.

More or less slender annual or perennial, tufted, shallow-rooted, 30–50 cm high, not viscid. *Culms* ± trigonous to terete below, smooth, 1.2–2 mm diam. *Leaves* flat or carinate, usually not septate-nodulose, ≤ culms, to 4 mm wide, pale yellow-green; midrib ± obvious, smooth or scabrous towards the apex; marginal prickles dense to sparse, irregularly spaced (0.1–0.7 mm apart), short, c. 0.05 mm long, flabellate to erect, papillate or occasionally aculeate; leaf sheaths not septate-nodulose, striate, not shining, pinkish brown, thin-textured. *Inflorescence* small-compound to compound, occasionally simple, spreading, 5–8 primary branches to 8 cm long; bracts suberect to spreading, 2–4 exceeding inflorescence. *Spikelets* 8–15 in subdigitate, loose, hemispherical to globose clusters of 1–1.5(–2) cm diam.; spikelets compressed, oblong, 5–11(–17) mm long, 1.8–4.0 mm wide in side view, (4–)6–12(–20)-flowered; rachilla may be thickened at maturity (to 0.15 mm thick), not to narrowly winged, wings to 0.05 mm wide; glume spacing 1.0–1.5 mm; spikelet falling as a unit, or rachilla persistent (perhaps only if plants are collected before senescence). *Glumes* narrow-ovate to elliptic, long-acute with ± straight mucro 0.1–0.2 mm long (whole glume somewhat excurved), yellow to red-brown at maturity (with quite bright yellow blotches when young), with broad green midrib, 1.8–2.3(–2.7) mm long, 0.5–1.0 mm wide, sides (1–)2(–3)-nerved with nerves often prominent and white, margins not inrolled but spreading widely at maturity and very narrowly hyaline. *Anthers* 0.6–1.1 mm long excluding appendage 0.2–0.5 mm long. *Nut* trigonous, narrow-obovate to narrow-elliptic with ± broad-acute apex, faces flat to convex, pale brown to dark red-brown, small-foveate to small-colliculate, glistening to shining, 1.2–1.6 mm long, ⅔ – ¾ as long as glume, 0.4–0.6 mm diam., falling separately from glume. Figure 32j–l.

Distribution: From the Kimberley region of Western Australia to the Darwin & Gulf region, Northern Territory. Figure 31d.

Habitat: Sandy loam or clay soils; in seasonally wet situations on levees and in gravelly creek-beds and around depressions in grassland.

The species is named after Mr Peter Latz of Alice Springs, who has studied and made extensive collections of Cyperaceae throughout the Northern Territory.

Distinctive in this Section by its spreading glumes, which have a very broad midrib (about half the width of the glume) with a strong nerve separating the midrib and the glume sides. The midrib is most obvious in younger plants when it is bright green, contrasting with the yellow-brown glume sides. At maturity the glumes are a fairly uniform dull brown, with the midrib distinguished by being thicker-textured than the sides. It occasionally grows with *C. viscidulus*, which differs in being a taller, slender perennial, with rather viscid spikelets that are generally narrower but with more flowers.

Specimens examined: Northern Territory: Darwin and Gulf: N of Nutwood Downs HS., near Kempsey Creek, *Blake 17563*, May 1947 (BRI). Victoria River: Top Springs–Victoria R. Downs road, Middle Creek, *Beauglehole 54564*, July 1976 (NT); Duncan Highway, 1.5 km S of Katherine–Wyndham road, *Beauglehole 51295, 51299*, May 1976 (NT); Saddle Creek, 22.9 miles [37 km] E Newry, *Chippendale 5989*, May 1959 (NT, BRI); Limbunya, *Dunlop 3549*, May 1974 (NT, BRI, CANB, NSW); Farquharsen Gap, *Latz 5372*, June 1974 (BRI, K, NSW ex NT, PERTH); Montejinni Station, *Latz 5270*, June 1974 (NSW); 50 km NNW of Inverway HS., *Latz 5415*, June 1974 (NSW, PERTH); Wave Hill area, *Stroder*, Mar 1971 (BRI 119346); 38 km NW of Top Springs Roadhouse on Victoria River Downs road, *Wilson 4753*, Apr 1983 (NSW, AD, BRI, DNA, H, K, P, PERTH); c. 18 km N of Victoria River Downs HS. on Timber Creek road, *Wilson 4763*, Apr 1983 (NSW); Victoria Highway, 27.6 km NE of Victoria R. Crossing, *Wilson 4902*, Apr 1983 (NSW, AD, CANB, DNA). Western Australia: Gardner: Ord R., *Durack*, May 1945 (PERTH); Caravan Creek, near Port Warrender, Mitchell Plateau, *Hnatiuk MP 118, MP 119*, June 1976 (PERTH).

Excluded name

C. inornatus Boeckeler (1875: 86) = **C. nutans** Vahl var. **eleusinoides** (Kunth) Haines, **synon. nov.**

TYPE: Port Mackay, *A. Dietrich 2595 (hb. Godeffroy 661)*, 1866–69; holo ?; probable iso B, L (both ex HBG).

This was tentatively put in the synonymy of *C. gunnii* subsp. *novae-hollandiae* by Kükenthal (1935–36). However, the two probable isotypes in B and L are referable to *C. nutans* var. *eleusinoides*. No specimens annotated by Boeckeler have been located. Both specimens seen are recent accessions from HBG, with typewritten labels, and it would be inappropriate to choose either of them as lectotype without checking further for replicates of that collection with original labels.

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References

Allan, R.D., Correll, R.L., & Wells, R.J. (1969) A new class of quinones from certain members of the family Cyperaceae. *Tetrahedron Letters* 53: 4669–4672.

Allan, R.D., Wells, R.J., Correll, R.L., & MacLeod, J.K. (1978) The presence of quinones in the genus *Cyperus* as an aid to classification. *Phytochemistry* 17: 263–266.

Bailey, F.M. (1902) *The Queensland flora*, part 6 (Diddams & Co.: Brisbane).

Barlow, B.A. (1986) A revised natural regions map for Australia. *Brunonia* 8: 387–392.

Beadle, N.C.W., Evans, O.D., & Carolin, R.C. (1982) *Flora of the Sydney region*, edn 3 (Reed: Sydney).

Bentham, G. (1878) *Flora Australiensis*, vol. 7.

Black, J.M. (1922) *Flora of South Australia*, part 1 (Govt Printer: Adelaide).

Black, J.M. (1924) Additions to the flora of South Australia No. 22. *Trans. & Proc. Roy. Soc. South Australia* 48: 253–257.

Black, J.M. (1929) *Flora of South Australia*, part 4 (Govt Printer: Adelaide).

Black, J.M. (1943) *Flora of South Australia*, edn 2, part 1 (Govt Printer: Adelaide).

Black, J.M. (1978) *Flora of South Australia*, edn 3, part 1 (Govt Printer: Adelaide).

Blackall, W.E., & Grieve, B.J. (1954) *How to know Western Australian wildflowers*, part 1 (Univ. Western Australia: Perth).

Blake, S.T. (1940) Notes on Australian Cyperaceae III. *Proc. Roy. Soc. Queensland* 51: 32–50.

Blake, S.T. (1943) Critical notes on the Gramineae and Cyperaceae of South Australia with descriptions of new species. *Trans. Roy. Soc. South Australia* 67: 42–61.

Blake, S.T. (1947a) Notes on Australian Cyperaceae VII. *Proc. Roy. Soc. Queensland* 58: 35–50.

Blake, S.T. (1947b) The Cyperaceae collected in New Guinea by L.J. Brass, II. J. Arnold Arbor. 28: 207–229.

Blake, S.T. (1954) The Cyperaceae collected in New Guinea by L.J. Brass, IV. *J. Arnold Arbor.* 35: 203–238.

Boeckeler, O. (1868-1874) Die Cyperaceen des Königlichen Herbariums zu Berlin. *Linnaea* 35: 397–512 (1868); *Linnaea* 36: 271–512 (1870); *Linnaea* 38: 223–256 (1874).

Boeckeler, O. (1875) Ein Beitrag zur Kenntniss der Cyperaceen-Flora Neuholland's und einiger polynesischer Inseln. *Flora* 58: 81–89, 107–112, 116–123.

Boeckeler, O. (1884) Neue Cyperaceen. *Bot. Jahrb.* 5: 497–521.

Briggs, B.G., & Johnson, L.A.S. (1979) Evolution in the Myrtaceae — evidence from inflorescence structure. *Proc. Linn. Soc. New South Wales* 102: 157–256.

Brown, R. (1810) *Prodromus Florae Novae Hollandiae.*

Brown, W.V. (1975) Variations in anatomy, associations, and origins of Kranz tissue. *Amer. J. Bot.* 62: 395–402.

Burbidge, N.T. (1946) Morphology and anatomy of the Western Australian species of *Triodia* R. Br. II. Internal anatomy of leaves. *Trans. Roy. Soc. South Australia* 70: 221–234.

Burbidge, N.T. (1953) The genus *Triodia* R. Br. (Gramineae). *Austral. J. Bot.* 1: 121–184.

Burbidge, N.T. (1959) *Notes on plants and plant habitats observed in the Abydos–Woodstock area, Pilbara district, Western Australia.* CSIRO Division of Plant Industry Technical Paper no. 12.

Burbidge, N.T. (1960) The phytogeography of the Australian region. *Austral. J. Bot.* 8: 75–212.

Burbidge, N.T., & Gray, M. (1970) *Flora of the Australian Capital Territory* (A.N.U. Press: Canberra).

Carolin, R.C., Jacobs, S.W.L., & Vesk, M. (1977) The ultrastructure of Kranz cells in the family Cyperaceae. *Bot. Gaz.* 138: 413–419.

Clarke, C.B. (1884) On the Indian species of *Cyperus*; with remarks on some others that specially illustrate the subdivisions of the genus. *J. Linn. Soc., Bot.* 21: 1–202.

Clarke, C.B. (1908) New genera and species of Cyperaceae. *Kew Bull. Misc. Inform. Add. Ser.* 8: 1–196.

Clarke, C.B. (1909) *Illustrations of Cyperaceae* (Williams & Norgate: London).

Cronquist, A. (1977) On the taxonomic significance of secondary metabolites in angiosperms *Pl. Syst. Evol., Suppl.* 1: 179–189.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L., & Leigh, J.H. (1981) *Plants of western New South Wales* (Govt Printer: Sydney).

Dell, B., & McComb, A.J. (1978) Plant resins — their formation, secretion and possible functions. *Adv. Bot. Research* 6: 277–316.

Denton, M.F. (1978) A taxonomic treatment of the Luzulae group of *Cyperus*. *Contr. Univ. Michigan Herb.* 11: 196–271.

Denton, M.F. (1983) Anatomical studies of the Luzulae group of *Cyperus* (Cyperaceae). *Syst. Bot.* 8: 250–262.
Dilcher, D.L. (1974) Approaches to the identification of angiosperm leaf remains. *Bot. Rev.* 40: 1–157.
Domin, K. (1915) Beiträge zur Flora und Pflanzengeographie Australiens, Abteilung 2 Embryophyta siphonogama, pars i: Gymnospermae, Monocotyledonae. *Biblioth. Bot.* 20(85): 243–551.
Dovey, L.G. (1935) Notes on the sedges (family Cyperaceae) found in the Bottle Creek section of the Baffle Creek Catchment Area, Port Curtis district. *Queensland Naturalist* 9: 90–92.
Druyts-Voets, E. (1970) Types van stengel- en bladstrukturen in het genus *Cyperus L. Natuurw. Tijdschr.* 52: 28–49.
Eardley, C.M. (1946) The Simpson Desert expedition, 1939 – Scientific reports: No. 7, Botany – part I: Catalogue of plants. *Trans. Roy. Soc. South Australia* 70: 145–174.
Edgar, E. (1964) The leafless species of *Juncus* in New Zealand. *New Zealand J. Bot.* 2: 177–204.
Edwards, P.I. (1981) *The journal of Peter Good.* Bull. Brit. Mus. (Nat. Hist.) Hist. Ser. vol. 9.
Eliasson, V. (1965) Studies in Galapagos plants. II Cyperales. *Svensk Bot. Tidskr.* 59: 469–491.
Erickson, R. (1969) *The Drummonds of Hawthornden* (Lamb Paterson: Osborne Park).
Ewart, A.J. (1931) *Flora of Victoria* (Melbourne U.P.: Melbourne).
Ewart, A.J., & Davies, O.B. (1917) *The Flora of the Northern Territory* (McCarron, Bird & Co.: Melbourne).
Federowicz, M.F. (1962) *The significance of the achene and stoma in the status of* Eucyperus *and* Mariscus *(Cyperaceae) based on the studies of plastic replicas.* Catholic Univ. America Biol. Studies No. 75.
Fitzgerald, W.V. (1918) The botany of the Kimberleys, north-west Australia. *J. & Proc. Roy. Soc. Western Australia* 3: 102–24.
Flinders, M. (1814) *A voyage to Terra Australis*, vols. 1 & 2, atlas.
Gardner, C.A. (1930) *Enumeratio plantarum australiae occidentalis*, part 1 (Govt Printer: Perth).
Gershenzon, J., & Mabry, T.J. (1983) Secondary metabolites and the higher classification of angiosperms. *Nord. J. Bot.* 3: 5–34.
Goetghebeur, P. (1989) Studies in Cyperaceae 9. Problems in the lectotypification and infrageneric taxonomy of *Cyperus* L. *Bull. Soc. Roy. Belg.* 122: 103–114.
Gordon-Gray, K.D., van Laren, L., & Bandu, V. (1978) Silica deposits in *Rhynchospora* species (Cyperaceae). *Proc. Electron Microscopy Soc. Southern Africa* 8: 83–84.
Gornall, R.J., & Bohm, B.A. (1978) Angiosperm flavonoid evolution: a reappraisal. *Syst. Bot.* 3: 353–368.
Gornall, R.J., Bohm, B.A., & Dahlgren, R. (1979) The distribution of flavonoids in the angiosperms. *Bot. Notiser* 132: 1–30.
Govindarajalu, E. (1974) The systematic anatomy of south Indian Cyperaceae: *Cyperus* L. subgen. *Juncellus, Cyperus* subgen. *Mariscus* and *Lipocarpha* R. Br. *J. Linn. Soc., Bot.* 68: 235–266.
Haines, R.W., & Lye, K.A. (1983) *The sedges and rushes of East Africa* (East African Nat. Hist. Soc.: Nairobi).
Harborne, J.B. (1980) New experimental approaches to plant chemosystematics. Pp. 39–70 in F.A. Bisby, J.G. Vaughan & C.A. Wright (eds), *Chemosystematics: principles and practice* (Academic Press: London).
Harborne, J.B., & Turner, B.L. (1984) *Plant Chemosystematics* (Academic Press: London).
Harborne, J.B., Williams, C.A., & Wilson, K.L. (1982) Flavonoids in leaves and inflorescences of Australian *Cyperus* species. *Phytochemistry* 21: 2491–2507.
Harborne, J.B., Williams, C.A., & Wilson, K.L. (1985) Flavonoids in leaves and inflorscences of Australian Cyperaceae. *Phytochemistry* 24: 751– 766.
Hattersley, P.W. (1983) The distribution of C_3 and C_4 grasses in Australia in relation to climate. *Oecologia* 57: 113–128.
Hattersley, P.W. (1984) Characterisation of C_4 type leaf anatomy in grasses (Poaceae). Mesophyll:bundle sheath area ratios. *Ann. Bot.* 53: 163–179.
Healy, A.J., & Edgar, E. (1980) *Flora of New Zealand*, vol. 3 (Govt Printer: Wellington).
Holm, T. (1904) Studies in the Cyperaceae. XXIII The inflorescence of *Cyperus* in North America. *Amer. J. Sci.* 18: 301–307.
Hooker, J.D. (1858) *Botany of the Antarctic voyage. Part III Flora Tasmaniae*, vol. 2(6).

Johnson, L.A.S., Briggs, B.G., & Blaxell, D.F. (1981) Proposals to amend Articles 11, 32 and 34 of the Code. *Taxon* 30: 230–233.
Johnson, R.W. (1964) *Ecology and control of brigalow in Queensland* (Qld Dept. Primary Industries: Brisbane).
Kern, J.H. (1963) Flora Malesiana Precursores XXXII: Some new Cyperaceae. *Blumea* 12: 23–30.
Kern, J.H. (1974) Cyperaceae [Part 1]. *Flora Malesiana* ser. 1, vol. 7(3): 435–753.
Krasan, F. (1864) Erläuterungen zum Verständniss der Spirre (anthela). *Flora* 47: 161–172.
Kükenthal, G. (1931) Cyperaceae novae vel minus cognitae X. *Feddes Repert. Spec. Nov. Regni Veg.* 29: 187-202.
Kükenthal, G. (1935–36) Cypereae. In A. Engler, *Das Pflanzenreich* IV 20 Heft 101.
Kükenthal, G. (1940a) Neue Cyperaceen aus dem malayischen und papuanischen Gebiet I. *Bull. Jard. Bot. Buitenzorg* ser. 3, 16: 300–323.
Kükenthal, G. (1940b) Neue Cyperaceen aus Neuguinea. *Bot. Jahrb. Syst.* 70: 463–468.
Kunth, K.S. (1837) *Enumeratio Plantarum*, vol. 2.
Le Cohu, M.-C. (1973) Examen au microscope électronique à balayage, des cônes de silice chez les Cypéracées. *Compt. Rend. Hebd. Séances Acad. Sci. Paris* ser. D, 277: 1301–1303.
Lehmann, J.G.C. (1846) *Plantae Preissianae*, vol. 2, part 1.
Leigh, J., Boden, R., & Briggs, J. (1984) *Extinct and endangered plants of Australia* (Macmillan: Melbourne/Sydney).
Levin, D.A. (1976) The chemical defenses of plants to pathogens and herbivores. *Ann. Rev. Ecol. Syst.* 7: 121–159.
Maiden, J.H., & Betche, E. (1916) *A census of New South Wales plants* (Govt Printer: Sydney).
Marcks, B.G. (1974) Preliminary reports on the flora of Wisconsin No. 66. Cyperaceae II — sedge family II. The genus *Cyperus* — the umbrella sedges. *Trans. Wisconsin Acad. Sci.* 62: 261–284.
Marek, S. (1958) A study on the anatomy of fruits of European genera in the subfamilies Scirpoideae Pax, Rhynchosporoideae Aschers. et Graebner and some genera of Caricoideae Pax. *Monogr. Bot.* 6: 151–177.
Mathis, C. (1966) Comparative biochemistry of hydroxyquinones. Pp. 245–270 in T. Swain (ed.), *Comparative Phytochemistry* (Academic Press: London).
Menu, M.A. (1908) *Etude anatomique du fruit et de la graine des Cypéracées* (Thesis, Univ. Paris, Ecole Supérieure de Pharmacie: Paris).
Metcalfe, C.R. (1971) *Anatomy of the mnocotyledons. V. Cyperaceae* (Oxford U.P.: London).
Moore, C., & Betche, E. (1893) *Handbook of the flora of New South Wales.*
Mueller, F. (1859) *Fragmenta Phytographiae Australiae*, vol. 1.
Mueller, F. (1874) *Fragmenta Phytographiae Australiae*, vol. 8.
Mueller, F. (1875) *Fragmenta Phytographiae Australiae*, vol. 9.
Mueller, F. (1886) *Plants collected in Capricornic Western Australia, by H.S. King, Esq.* Preprint of *Proc. Roy. Soc. Victoria* 23: 49–57 (1887).
Mueller, F., & Tate, R. (1890) List of plants collected during Mr Tietkens' expedition into Central Australia, 1889. *Trans. & Proc. Roy. Soc. South Australia* 13: 94–106.
Piperno, D.R. (1989) The occurrence of phytoliths in the reproductive structures of selected tropical angiosperms and their significance in tropical paleoecology, paleoethnobotany and systematics. *Rev. Palaeobot. Palynol.* 61: 147–173.
Poiret, J.L.M. (1817) *Encyclopédie Méthodique Botanique, Suppl. 5.*
Probst, R. (1949) *Wolladventivflora Mitteleuropas* (Solothurn).
Ragonese, A.M., Guaglianone, E.R., & De Strittmatter C.D. (1984) Desarrollo del pericarpio con cuerpos de silice de dos especies de *Rhynchospora* Vahl (Cyperaceae). *Darwiniana* 25: 27–41.
Raven, J.A. (1983) The transport and function of silicon in plants. *Biol. Rev.* 58: 179–207.
Ray, T.B., & Black, C.C. (1979) The C_4 pathway and its regulation. Pp. 77–101 in M. Gibbs & E. Latzko (eds), *Photosynthesis II — Photosynthetic carbon metabolism and related processes* (Springer-Verlag: Berlin).
Raynal, J. (1971) Quelques notes morphologiques sur les Cypéracées. *Mitt. Bot. Staatssamml. München* 10: 589–603.
Raynal, J. (1972) Répartition et évolution des modes de photosynthèse chez les Cypéracées. *Compt. Rend. Hebd. Séances Acad. Sci. Paris*, ser. D, 275: 2231-2234.
Raynal, J. (1973) Notes Cypérologiques: 19. Contribution à la classification de la sous-famille des *Cyperoideae*. *Adansonia* ser. 2, 13: 145–171.

Rodway, L. (1903) *The Tasmanian fora* (Govt Printer: Hobart).
Ryves, T.B. (1976) Notes on some wool-alien Cyperaceae from Blackmoor, N. Hants. *Watsonia* 11: 69–70.
Sangster, A.G., & Parry, D.W. (1981) Ultrastructure of silica deposits in higher plants. Pp. 383–407 in T.L. Simpson & B.E. Volcani (eds), *Silicon and siliceous structures in biological systems* (Springer-Verlag: New York).
Schuyler, A.E. (1971) Scanning electron microscopy of achene epidermis in species of *Scirpus* (Cyperaceae) and related genera. *Proc. Acad. Nat. Sci. Philadelphia* 123: 29–52.
Sharpe, P. (1989) Cyperaceae. Pp. 277–355 in T.D. Stanley & E.M. Ross, *Flora of south-eastern Queensland*, vol. 3 (Qld Dept Primary Industries: Brisbane).
Snow, M. (1955) Spirodistichy re-interpreted. *Trans. Roy. Soc. London*, ser. B, Biol. Sci., 239: 45–88.
Société française des Chrysanthémistes (1905) *Répertoire de couleurs pour aider à la détermination des couleurs des fleurs, des feuillages et des fruits* (Oberthur: Paris).
Specht, R.L., & Mountford, C.P. (1958) *Records of the American-Australian scientific expedition to Arnhem Land; vol. 3, Botany and plant ecology* (Melbourne U.P.: Melbourne).
Sprengel, K.P.J. (1824) *Systema vegetabilium*, edn 16, vol. 1.
Stearn, W.T. (1973) *Botanical Latin*, edn 2 (David & Charles: Newton Abbot).
Steudel, E.G. (1854) *Synopsis plantarum glumacearum*, vol. 2, part 1.
Stuessy, T.F., & Crawford, D.J. (1983) Flavonoids and phylogenetic reconstruction. *Pl. Syst. Evol.* 143: 83–107.
Takeda, T., Ueno, O., Samejima, M., & Ohtani, T. (1985) An investigation for the occurrence of C_4 photosynthesis in the Cyperaceae from Australia. *Bot. Mag. Tokyo* 98: 393–411.
Tate, R. (1890) *Handbook to the flora of extratropical South Australia.*
Tate, R. (1896) *Horn scientific expedition to central Australia. Part III. Section 2: Botany.*
Toivonen, H., & Timonen, T. (1976) Perigynium and achene epidermis in some species of *Carex*, subg. *Vignea* (Cyperaceae), studied by scanning electron microscopy. *Ann. Bot. Fennici* 13: 49–59.
Troll, W. (1964) *Die Infloreszenzen* (G. Fischer Verlag: Stuttgart).
Tucker, G.C. (1983) *The taxonomy of* Cyperus *(Cyperaceae) in Costa Rica and Panama.* Syst. Bot. Monogr. vol. 2.
Ueno, O., Takeda, T., & Maeda, E. (1988) Leaf ultrastructure of C_4 species possessing different Kranz anatomical types in the Cyperaceae. *Bot. Mag. (Tokyo)* 101: 141–152.
Walker, D. (1972) *Bridge and Barrier: the natural and cultural history of Torres Strait.* Research School Pacific Studies Public. BG/3. (Austral. Nat. Univ.: Canberra).
Weberling, F. (1989) *Morphology of flowers and inflorescences* [transl. by R.J. Pankhurst] (Cambridge Univ. Press: Cambridge).
Williams, C.A., & Harborne, J.B. (1975) Luteolin and daphnetin derivatives in the Juncaceae and their systematic significance. *Biochem. Syst. Ecol.* 3: 181–190.
Willis, J.H. (1962) *A handbook to plants in Victoria*, edn 1, vol. 1 (Melbourne U.P.: Melbourne).
Willis, J.H. (1970) *A handbook to plants in Victoria* edn 2, vol. 1 (Melbourne U.P.: Melbourne).
Wilson, K.L. (1980) Notes on some Australian species of Cyperaceae. *Telopea* 1: 457–467.
Wilson, K.L. (1981a) *Cyperus*. Pp. 502–509 in J.P. Jessop (ed.), *Flora of central Australia* (Reed: Sydney).
Wilson, K.L. (1981b) Revision of the genus *Mesomelaena* (Cyperaceae). *Telopea* 2: 181–195.
Wilson, K.L. (1987) *Cyperus*. Pp. 1123–1140 in N.C.W. Beadle, *Students flora of north eastern New South Wales*, part 6 (Univ. New England: Armidale).
Wollenweber, E. & Dietz, V.H. (1981) Occurrence and distribution of free flavonoid aglycones in plants. *Phytochemistry* 20: 869–932.

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Alloxylon (Proteaceae), a new genus from New Guinea and eastern Australia

Peter H. Weston and Michael D. Crisp

Abstract

Weston, Peter H.[1], and Crisp, Michael D.[2] ([1] National Herbarium of New South Wales, Royal Botanic Gardens, Sydney NSW Australia 2000; [2] Australian National Botanic Gardens, GPO Box 1777, Canberra ACT Australia 2601; present address: Division of Botany and Zoology, Australian National University, GPO Box 4, Canberra ACT 2601) 1991. Alloxylon *(Proteaceae), a new genus from New Guinea and eastern Australia.* Telopea *4(3): 497–507.* *Oreocallis* sens. lat. consists of two distinct clades, one in South America, the other in Australasia, that together are likely to be paraphyletic. Newly sampled characters strongly support the monophyly of the Australasian group. We describe the new genus *Alloxylon* to accommodate the Australasian species of *Oreocallis* sens. lat. and revise its species. *Alloxylon flammeum* is described as new and new combinations are made for *A. brachycarpum*, *A. wickhamii* and *A. pinnatum*.

Introduction

Cladistic analyses of the subtribe Embothriinae of the family Proteaceae (Weston & Crisp 1987, in prep.) show the genus *Oreocallis* R. Br. sens. lat. to comprise two branches of an unresolved trichotomy. The third branch is the genus *Telopea*, a well corroborated clade of five species. The sister group to this trichotomy is *Embothrium*, the only other genus in the Embothriinae. According to these results, *Oreocallis* is likely to be paraphyletic, necessitating a nomenclatural rearrangement in order to ensure that all formal names apply to monophyletic groups. Two obvious nomenclatural alternatives are to (a) sink *Telopea* and *Oreocallis* into a single genus, or (b) elevate the two distinct groups within *Oreocallis* sens. lat. to generic rank. We have chosen the latter alternative for the following reasons. Firstly, *Telopea* and both clades in *Oreocallis* sens. lat. are more thoroughly characterised by synapomorphies than the group that includes all three of these clades. Option (b) is thus more likely to be nomenclaturally stable than option (a). Secondly, option (b) requires fewer nomenclatural changes than does option (a): only four species are moved into a new genus whereas option (a) requires either that five species of *Telopea* be moved to *Oreocallis* or that six species of *Oreocallis* be moved to *Telopea* (*Telopea* and *Oreocallis* were both established by Brown (1810) and so are equal in priority). Therefore we here establish the new genus *Alloxylon* to accomodate the three Australian and one New Guinean species formerly included in *Oreocallis*. *Oreocallis* sens. strict. comprises two species that broadly overlap in distribution in Peru and Ecuador, *O. grandiflora* and *O. mucronata*.

Since the publication of our first cladistic analysis of the Embothriinae (Weston & Crisp 1987), knowledge of the wood, fruits, leaf anatomy and seedlings in the Embothriinae has improved considerably, providing a number of new characters for cladistic analysis. Moreover, we now realise that there are three species, one previously unnamed, in north-eastern Australia and New Guinea, not just one as we had previously believed, nor two as Sleumer (1954) had thought.

The data presented here were compiled from herbarium specimens, cultivated plants, field observations and literature. Specimens held by the following herbaria were

examined: BRI, CANB, CBG, MEL, MO, NSW, QRS, SYD. All Australian species are in cultivation at the Royal Botanic Gardens Sydney.

Terms denoting form are taken from Stearn (1973), particularly his figure 19. Inflorescence terminology follows that of Johnson & Briggs (1975) and Weston & Crisp (1987), while leaf venation is described using the terms of Hickey (1973). Flower orientation with respect to the unit inflorescence axis is described as diagonal (opposed to anteroposterior) following Johnson & Briggs (1963, 1975) and Weston & Crisp (1987).

Taxonomy

Alloxylon *P. Weston & Crisp,* **gen. nov.**

Arbores parvae ad elatae, in silvis humidis clausis crescentes; cotyledonibus succulentis; bracteis involucralibus nullis; floribus zygomorphis, in alabastro leviter incurvis, roseis ad rubris; perianthio in alabastro plus minusve cylindrico, tubo proximali lineari et limbo distali introrso-obliquo subgloboso, tepalis cohaerentibus postice in tubo fisso post anthesin; polline triporato; pollinophoro valde introrso-obliquo, plus minusve late elliptico ad basin, late conico lateribus concavis, stigmate parvo circulari terminato; fructu folliculi, mesocarpio interiore lignoso, non late dehiscenti, post dehiscentiam cymbiformi; seminibus 6–14, ala seminis basalis longitudine latitudineque loculum fructus fere aequanti sed in seminibus distalibus successive breviore.

Type: *Alloxylon flammeum* P. Weston & Crisp.

Cotyledons fleshy, epigeal, shortly auriculate, green after germination. First two seedling leaves opposite; all later leaves alternate, with spiral phyllotaxis. Small to tall rainforest trees. Trichomes unbranched. Glandular hairs absent. Adult leaves simple and entire or pinnate with entire leaflets, tapered to petiole. Intermediate leaves simple and entire or deeply pinnatisect or pinnate. Seedling leaves simple, deeply lobed or entire. Conflorescences axillary or terminal, pseudoracemose, laterally bearing flower-pairs (unit inflorescences sensu Johnson & Briggs 1975), basitonic or acrotonic, solitary or aggregated into superconflorescences; involucral bracts absent; unit inflorescences lacking floral bracts and peduncles. Flowers zygomorphic, diagonally oriented with respect to unit inflorescence axis, gently incurved in bud, hermaphrodite, ornithophilous, pink to red; torus strongly oblique, lowest on posterior side of flower; perianth ± cylindrical in bud, consisting of proximal linear claw and distal inward-oblique, subglobose limb; segments cohering posteriorly in split tube after anthesis; staminal filaments adnate to perianth segments; anthers circular, introrse, with connective projecting slightly beyond tips of loculi; pollen triporate; hypogynous glands connate, forming posterior, lunate nectary; gynoecium glabrous, c. as long as perianth; gynophore well-developed, half as long as style or more; ovary slightly swollen, containing numerous, laterally attached, winged, anatropous ovules; pollen-presenter strongly inward-oblique, ± broad-elliptical at base, broadly conical with concave sides, terminated by small circular stigma. Fruit a follicle, narrow-ellipsoid to narrow-obovoid, with woody inner mesocarp, not opening widely, canoe-like on dehiscence. Seeds 6–14, interleaved by papery, dark brown interseminal layer; embryo flattened, fleshy; wing distal to embryo, narrow-oblong, truncate to rounded or acute; wing of basal seed nearly as long and wide as loculus of fruit but progressively shorter in distal seeds; raphe entering seed on outside edge of embryo, running along edge onto wing then running diagonally across wing to inside edge near distal tip, sharply reversing and running along inside margin of wing to embryo.

Three species endemic in eastern Australia, and one endemic in New Guinea and the Aru Islands. This genus was formerly included in *Oreocallis*, which, in our delimitation, comprises two species in Peru and Ecuador. All species, but *A. flammeum* in particular, are showy flowering trees suitable for cultivation in mildly temperate to tropical areas. The generic name is derived from the Greek *allo* (other) and *xylon* (wood), referring to the wood anatomy of the genus, which is markedly different from that of other Proteaceae (Chattaway 1948; Papassotiriou, Weston & Wilkins unpublished data).

Key to the species

1 Adult leaves mostly pinnate, some simple; leaf(let) apices attenuate; venation of terminal leaflets and simple leaves eucamptodromous; conflorescences 50–140-flowered, solitary; pollen deep crimson ..... **1. A. pinnatum**

1* Adult leaves simple and entire; leaf apices obtuse or acute; venation brochidodromous; conflorescences 4–52-flowered, often grouped in superconflorescences; pollen yellow.

2 Flowers glabrous, dull pinkish red; conflorescences 4– 20-flowered, symmetrical to slightly asymmetrical; leaves coriaceous ..... **2. A. wickhamii**

2* Flowers covered in (sometimes very short) ferruginous hairs, pinkish red to bright orange-red; conflorescences (2–)10–52-flowered, strongly asymmetrical, the pedicels strongly curved so that all flowers are similarly oriented on the same side of conflorescence axis; leaves chartaceous.

3 Hairs mostly spreading, straight to curly, 0.1–0.5 mm long; young branchlets densely hairy ..... 3. **A. flammeum**

3* Hairs appressed, straight, to 0.1 mm long; young branchlets sparsely to moderately hairy ..... **4. A. brachycarpum**

1. Alloxylon pinnatum *(Maiden & Betche) P. Weston & Crisp*, **comb. nov.**

Basionym: *Embothrium wickhamii* W. Hill & F. Muell. var. *pinnatum* Maiden & Betche, Proc. Linn. Soc. New South Wales 35: 795 (1910).

Type citation: 'Dorrigo (J.L. Boorman; December, 1909).' Lectotype (here designated): New South Wales: Dorrigo, *J. L. Boorman s.n.*, Dec 1909 (NSW 235580); isolecto B, BRI, MEL (2 sheets), NSW (2 sheets).

Synonyms: *Embothrium pinnatum* (Maiden & Betche) C. White, Proc. Roy. Soc. Queensland 60: 43 (1950).

Oreocallis pinnata (Maiden & Betche) Sleumer, Bot. Jahrb. Syst. 76: 203 (1954).

Illustration: M. Flockton in Maiden, Forest Fl. N.S.W. 5: t. 167 (1911), as *Embothrium wickhamii* var. *pinnatum*.

Seedlings and juveniles differing from adults as follows: first 6–8 leaves simple, entire, ovate to elliptical (or rarely one of them 2-lobed), discolorous, (1.5–)3.5–5.0 cm long, (4–)10–25 mm wide, tapered to base, not petiolate, acute to acuminate; venation brochidodromous, with secondary veins diverging at 30–70 degrees from midvein, secondary and some lower order veins protruding slightly when dried; later

seedling leaves simple and entire to 12th–22nd node, narrow-elliptical to -obovate, discolorous, 7.5–18 cm long, 13–55 mm wide, with attenuate base, petiolate, acuminate; venation brochidodromous, with secondary veins diverging at 25–40 degrees from midvein; intermediate leaves pinnate with 2–9 leaflets, discolorous, (10–)15–35 cm long; venation of terminal leaflet brochidodromous.

Adults: trees to 24 m high and 0.6 m d.b.h., not buttressed. *Bark* grey-brown, with a dense cover of fine lenticels. *Hairs* short, mostly 0.1–0.45 mm long, ferruginous when young but aging to grey, antrorse, straight. *Young branchlets* sparsely to moderately hairy, soon glabrescent. *Leaves* mostly pinnate with few simple entire leaves (particularly just below conflorescences), concolorous to slightly discolorous, chartaceous, bright green when immature; petiole sparsely to moderately hairy when immature (densest on adaxial surface and at base), glabrescent to sparsely hairy when mature; laminae narrow-elliptical to narrow-ovate, attenuate at base and tip, with flat to slightly recurved margins, sparsely hairy when immature, glabrescent when mature; midvein protruding prominently and ± equally on both surfaces; tertiary and lower order veins sunken; pinnate leaves with 2–11 leaflets, 10–50 cm long; petiole 35–145 mm long; lateral leaflets usually asymmetrical at base, often slightly falcate, 5.0–14.5 cm long, 8–21 mm wide, forming angle of 22–30 degrees at base; venation usually brochidodromous or sometimes eucamptodromous, with secondary veins diverging at 30–45 degrees; secondary veins usually sunken; terminal leaflet with lower length:width ratio than lateral leaflets, occasionally asymmetrical or deeply 2–3-lobed, more attenuate at base than lateral leaflets, 8–18 cm long, 17–34 mm wide, forming angle of 35–45 degrees at base; venation usually eucamptodromous or occasionally brochidodromous, with secondary veins diverging at 13–30(–40) degrees; secondary veins protruding proximally but sunken distally, most prominent on adaxial surface; simple leaves similar to terminal leaflets but with higher length:width ratio, 8–23 cm long, 11–31 mm wide, forming angle of 22–30 degrees at base; petiole 8–45 mm long. *Conflorescences* 50–140-flowered, terminal or rarely axillary, acrotonic with 1–11 basal leaves (uppermost 0–11 being simple) or rarely basitonic, solitary, symmetrical or slightly asymmetrical; axis moderately hairy; bracts of flower-pairs mostly linear-triangular to -oblong, caducous or persistent, but often basal 1–6(–20) flower-pairs subtended by reduced simple entire leaves. *Flowers* bright pink, glabrous; pedicels 30–60 mm long; perianth 30–38 mm long, widest below middle and tapering slightly to ends of claw; pollen deep crimson; style c. twice as long as gynophore. Body of follicle 5–9 cm long; seeds 8-11. Figure 1.

Flowering period: November to January.

Distribution and habitat: Australia; vicariously distributed in the Dorrigo area, New South Wales, and the McPherson Range, New South Wales and Queensland (Figure 2a). Mountain slopes and plateaux, 700–1250 m altitude, on soils derived from sedimentary rocks, metasediments, and volcanics, in warm-temperate rainforest dominated for example by *Ceratopetalum apetalum*, rarely in wet eucalypt forest.

Conservation status: 3RC. Both parts of the distribution of *A. pinnatum* cover comparatively small geographic ranges. Moreover, it is not a common species where it does occur. Surprisingly, it is not known from any of the warm-temperate rainforests that occur between the disjunct parts of its distribution. Some of these, such as the Washpool rainforests, are quite extensive.

Selected specimens (40 examined): Queensland: Moreton: Tomewin, near Springbrook, 28°14'S, 153°23'E, *Andersen s.n.*, 8 Nov 1968 (BRI); Roberts Plateau, *Shirley 645/18*, Feb 1918 (BRI, NSW). New South Wales: North Coast: Tyalgum Ridge, Limpinwood Nature Reserve, 28°18'S, 153°08'30"E, *Coveny 9935 & Haegi*, 3 Dec 1977 (BRI, NSW); Woolgoolga Creek dam, *Floyd 1957*, 15 May 1983 (NSW); Dorrigo National Park, 8 km along road to Never Never from ranger

Figure 1. a, juvenile leaf of *A. flammeum* (x ¼); **b,** adult leaf of *A. flammeum* (x ¼); **c,** superconflorescence of *A. flammeum* (x ½); **d–e,** pollen presenter of *A. flammeum* (x 5); **f,** hypogynous gland of *A. flammeum* (x 5); **g,** flower pair of *A. flammeum* (x ½); **h,** fruit of *A. wickhamii* (x ½); **i,** seed of *A. wickhamii* (x ½); **j,** pinnate leaf of *A. pinnatum* (x ¼); **k,** conflorescence of *A. pinnatum*. (Drawn from *Constable*, cultivated, Royal Botanic Gardens Sydney, 11.1958 (a–b), *Weston 402* (c), *Weston 406* (d–g), *Smith 4162A* (h-i), *Floyd 1957* (j), *Salasoo 1878* (k).)

station, *Crisp 7590 & Taylor*, 3 Nov 1984 (CBG, MEL, NSW). Northern Tablelands: Mt Hyland Nature Reserve, 30°10'S, 152°28'E, *Richards 93 & Weston*, 1 Feb 1988 (BRI, CBG, K, MEL, MO, NSW, QRS). CULTIVATED: Epping (New South Wales), *Hazlewood s.n.*, 2 Dec 1958 (NSW 48284).

2. Alloxylon wickhamii *(W. Hill & F. Muell.) P. Weston & Crisp*, **comb. nov.**

BASIONYM: *Embothrium wickhamii* W. Hill & F. Muell., Fragm. 8: 164 (1874) (as *E. wickhami*).

TYPE CITATION: 'In monte Bellenden-Kerii, altitudine circiter 2500 pedum, ubi Heliciae Youngianae adsociatum; Walt. Hill.'

LECTOTYPE (here designated): QUEENSLAND: Bellenden Ker, 2500 ft altitude, *W. Hill 204*, – (MEL 56276).

RESIDUAL SYNTYPE: Bellenden Ker, Qld, *W. Hill 41*, – (MEL 56277).

SYNONYM: *Oreocallis wickhamii* (W. Hill & F. Muell.) Sleumer, Bot. Jahrb. Syst. 76: 203 (1955).

Seedlings and juveniles differing from adults as follows: first pair of leaves narrow-ovate to -elliptical, acute, 6.5–8.0 cm long, 11–22 mm wide, chartaceous, not petiolate but tapered to base, bright green when immature; later seedling leaves progressively having higher length:breadth ratio, widest part closer to tip, less acute, longer, petiolate from c. 10th node; intermediate leaves narrow- to linear-obovate to -oblong, acute to obtuse, to 41 cm long, 21–60 mm wide, chartaceous, pinkish purple when immature, with undulate margins.

Adults: trees to 30 m high and 0.6 m d.b.h. *Bark* grey, reticulately and shallowly fissured with brown lenticels. *Hairs* minute, mostly < 0.1 mm long, ferruginous to grey, appressed, straight, virtually restricted to dormant buds. *Branchlets* glabrous to sparsely hairy when immature, soon glabrescent. *Leaves* simple, entire, 5–17 cm long, 11–34 mm wide, discolorous, coriaceous, pinkish purple when immature; petiole 12–30 mm long, glabrous to sparsely hairy when immature, glabrescent when mature; lamina mostly narrow-obovate or occasionally narrow-elliptical, forming angle of 30–50 degrees at base, obtuse or rounded at apex, with flat margins, glabrous to sparsely hairy when immature, glabrescent when mature; venation brochidodromous, with secondary veins diverging at 55–70 degrees; midvein protruding slightly on adaxial surface and prominently on abaxial surface; lower order veins sunken. *Conflorescences* 4–20-flowered, terminal or axillary, basitonic or acrotonic with 1–10 basal leaves, solitary or aggregated in superconflorescences of 2–5 at ends of branches, symmetrical to slightly asymmetrical; axis sparsely hairy; bracts of flower-pairs mostly narrow-triangular to -oblong but often the basal 1–2 flower-pairs subtended by reduced leaves, persistent. *Flowers* dull pinkish red, glabrous; pedicels (15–)20–40 mm long; perianth 25–40 mm long, widest at base and distinctly tapering to tip of claw; pollen yellow; style c. twice as long as gynophore. Body of follicle 5.5–12 cm long; seeds 6–11. Figure 1.

FLOWERING PERIOD: October to November.

DISTRIBUTION AND HABITAT: Australia; north-eastern Queensland from Mt Bartle Frere to Cape Tribulation (Figure 2b). Mountainous areas, on soils derived from granite or metasediments, from 200 to 1220 m altitude, in tropical rainforest.

CONSERVATION STATUS: Not rare or endangered; it is fairly common through a relatively large area of the rainforests of the Cairns region.

The names *Embothrium wickhamii* and *Oreocallis wickhamii* were misapplied to *Alloxylon flammeum* until very recently. The two species were either treated as con-

specific (e.g. Sleumer 1954, Weston & Crisp 1987) or *A. wickhamii* was regarded as an undecribed species (e.g. Sankowsky et al. 1986).

SELECTED SPECIMENS (28 examined): QUEENSLAND: Cook: Gold Hill, summit ridge, 16°05'S, 145°17'E, *Weston 463, Sankowsky & Hind*, 12 Aug 1986 (NSW); Timber Reserve 55 Whyanbeel, 16°20'S, 145°20'E, *Hyland 7748*, 9 Oct 1974 (BRI, CANB, NSW, QRS); State Forest Reserve 607, Bridle Logging Area, 16°58'S, 145°37'E, *Gray 3745*, 29 Nov 1984 (NSW, QRS); State Forest Reserve 194, Compartment 52, 17°15'S, 145°25'E, *Hyland 3133*, 22 Nov 1974 (BRI, CANB, NSW, QRS); WNW ridge of Mt Bartle Frere above Bobbin Bobbin Falls, 17°23'S, 145°46'E, *Weston 954, Sankowsky & Hind*, 23 Aug 1986 (NSW). CULTIVATED: Bushland Nursery, Sunnybank Hills (Queensland), *Lebler s.n.*, 7 Dec 1973 (BRI).

3. Alloxylon flammeum *P. Weston & Crisp*, sp. nov.

Arbores ad 33 m alti et 0.6 m d.b.h.; pilis brevibus, plerumque 0.1–0.5 mm longis, ferrugineis juventute sed aetate provecta canis, plerumque patentibus, rectis ad crispis; ramulis juvenilibus pilis densis, demum glabrescentibus; plantulae foliis primo ad secundo vel quarto profunde trilobatis vel bilobatis, postea ad nodum 20–35 simplicibus integrisque, angusto-ellipticis; foliis intermediis primo anguste ad profunde pinnatisectis lobis 2–9, postea integris lineare ellipticis ad lineare obovatis; foliis adultis simplicibus integris, 8–25 cm longis, 20–25 mm latis, discoloribus chartaceis, immaturis prasinis; lamina angusto-elliptica ad angusto-obovata, ad basin angulum 22–55°

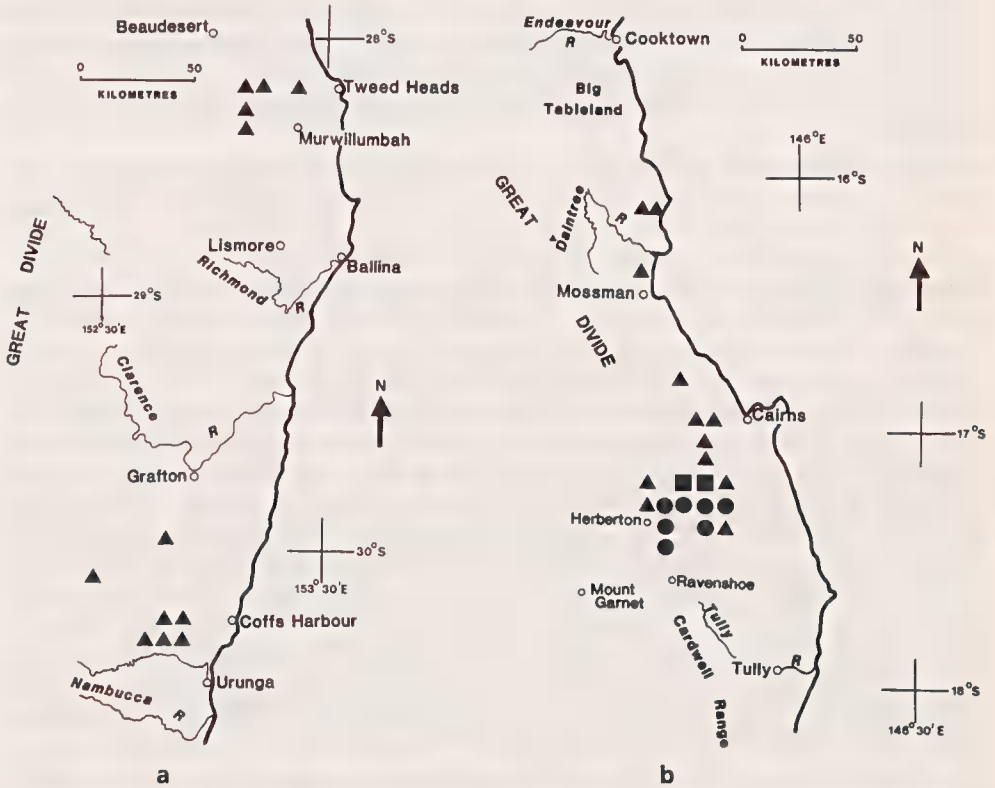

Figure 2. Distributions of species of *Alloxylon*; all symbols represent presence of one or more collection localities in a 5 x 5 minute grid square. **a,** *A. pinnatum* (south-eastern Queensland and northern New South Wales); **b,** *A. wickhamii* (triangle), *A. flammeum* (circle), and both of these species (square) (northern Queensland).

formanti, obtusa ad acuta; indumento costae aetate immatura pilis moderato vel denso, aetate matura glabrescenti; venatione brochidodroma, venis secundariis sub angulo circa 50–70° patentibus; folii pagina abaxiali costa leviter protrudenti, venis depressis; conflorescentiis floribus 10–52, pro parte maxima axillaribus vel ramifloris, basitonicis vel rarissime acrotonicis foliis 1–2 basalibus, valde asymmetricis, 2–20 in superconflorescentias ad extremum ramorum plerumque aggregatis, rachide pilis densis; floribus vivide miniatis, pedicellis 25–43 mm longis, indumento moderate denso; perianthio 35–50 mm longo, infra medium latissimo et ungue versus extrema ambo leviter contracto, extus indumento moderate denso; polline flavo.

HOLOTYPE: QUEENSLAND: Cook: Tolga Scrub, 17°14'S, 145°29'E, *G. G. Sankowsky 626 & P. Radke*, Aug 1987 (NSW 235579).

ISOTYPES: BRI, CBG, K, MEL.

[*Embothrium wickhamii* auct. non W. Hill & F. Muell.: Bailey, Queensland Agric. J. 5: 403 (1899)]

ILLUSTRATION: Bailey, Queensland Agric. J. 5: t.143 (1899), as *Embothrium wickhamii*.

Seedlings and juveniles differing from adults as follows: young stems sparsely to moderately hairy, soon glabrescent. First 2–4 seedling leaves deeply trilobed or less frequently bilobed, 3.5–7.0 cm long, tapered to base, not petiolate, acute, sparsely hairy when immature, glabrescent when mature; later seedling leaves simple and entire to 20–35th node, narrow-elliptical, 6.5–18.0 cm long, 13–22 mm wide, petiolate from c. 10th node, acute; early intermediate leaves shallowly to deeply pinnatisect with 2–9 lobes, (18–)30–50 cm long; midveins of lobes protruding but less prominently so than primary midvein, mostly diverging at 30–40 degrees from primary midvein; later intermediate leaves entire, linear-elliptical to -obovate, 25–40 cm long, 33–45 mm wide.

Adults: trees to 33 m high and 0.6 m d.b.h. *Bark* grey, reticulately and shallowly fissured with prominent brown lenticels. *Hairs* short, mostly 0.1–0.5 mm long, ferruginous when young but aging to grey, mostly spreading, straight to curly. *Young branchlets* densely hairy, eventually glabrescent with age. *Leaves* simple, entire, 8–25 cm long, 20–45 mm wide, discolorous, chartaceous, bright green when immature; petiole 15–25 mm long, moderately to densely hairy when immature, sparsely so at base but otherwise glabrescent when mature; lamina narrow-elliptical to narrow-obovate, forming angle of 22–55 degrees at base, obtuse to acute, with flat to slightly recurved margins, with moderately to densely hairy midvein but otherwise sparsely hairy when immature, glabrescent when mature; venation brochidodromous, with secondary veins diverging at 50–70 degrees; midvein protruding slightly on adaxial surface and prominently on abaxial surface; lower order veins sunken. *Conflorescences* 10–52-flowered, mostly axillary or ramiflorous, basitonic or very rarely acrotonic with 1–2 basal leaves, mostly aggregated in superconflorescences of 2–20 at ends of branches, strongly asymmetrical, pedicels curved so that all flowers are similarly oriented on same side of conflorescence axis; axis densely hairy; bracts of flower-pairs narrow-triangular to -oblong, mostly persistent. *Flowers* bright orange-red; pedicels 25–43 mm long, moderately hairy; perianth 35–50 mm long, widest below middle and tapering slightly to ends of claw, moderately hairy on outside; pollen yellow; style c. twice as long as gynophore. Body of follicle 7–10 cm long; seeds 8–10. Figure 1.

CHROMOSONE NUMBER: $2n = 22$ (Johnson & Briggs 1963: 24, cited as *Oreocallis wickhamii*; voucher *Constable NSW 48283*).

FLOWERING PERIOD: August to October.

DISTRIBUTION AND HABITAT: Australia; restricted to the Atherton Tableland, north-eastern Queensland, from Danbulla south to the Upper Barron River (Figure 2b). Plateau summit at 700–820 m altitude, on basalt-derived soil, in tropical rainforest.

CONSERVATION STATUS: 2VC. The habitat of *A. flammeum* has been cleared almost completely for agriculture. It survives in the wild in a few remnant patches of rainforest near Atherton, including some small national parks. It is much sought after as a horticultural subject and cultivated plants probably outnumber those remaining in the wild.

Since last century, *A. flammeum* has been misidentified as *A. wickhamii* although these species are readily distinguished even with only vegetative material. Ferdinand Mueller (one of the authors of *Embothrium wickhamii*), for example, determined a specimen of *A. flammeum*, collected in 1881 (near Trinity Bay, *Karsten s.n.*) as '*E. wickhami*'. This confusion persisted until very recently (see e.g. Weston & Crisp 1987: 22).

SELECTED SPECIMENS (36 examined): QUEENSLAND: Cook: Danbulla Forest Reserve Python Hill, 17°10'S, 145°40'E, *Stocker 944*, 30 Aug 1972 (BRI, QRS); N of Malanda – Lake Barrine road, between Anderson Rd and Johnstone River, 17°20'S, 145°38'E, *Gillanders & Hardy s.n.*, 25 Jul 1987 (BRI, CBG, NSW, QRS); State Forest Reserve 191 Barron, 17°20'S, 145°30'E, *Irvine 1575*, 10 Sep 1975 (BRI, CANB, NSW, QRS); State Forest Reserve 194, East Barron Experimental Plot 38, 17°25'S, 145°29'E, *Risley 219*, 10 Jan 1978 (QRS). CULTIVATED: Bellingen (New South Wales), *Crisp 7589 & Taylor*, 3 Nov 1984 (CBG, NSW).

4. Alloxylon brachycarpum *(Sleumer) P. Weston & Crisp*, **comb. nov.**

BASIONYM: *Embothrium brachycarpum* Sleumer, Bot. Jahrb. Syst. 70: 130 (1939).

TYPE CITATION: 'Brit.-Papua: Lower Fly River, east bank opp. Sturt Island, ... Oct. 1936 (L.J. Brass n. 8170, Typus in Herb. Arnold Arboretum und Herb. Berlin).'

LECTOTYPE (here designated): PAPUA NEW GUINEA: Lower Fly River, east bank opp. Sturt Island, *L.J. Brass 8170*, Oct 1936 (B).

ISOLECTOTYPE: A (n.v.).

SYNONYM: *Oreocallis brachycarpa* (Sleumer) Sleumer, Bot. Jahrb. Syst. 76: 203 (1954); Sleumer, Fl. Males. ser. 1, 5: 201-203 (1955).

ILLUSTRATION: Sleumer, Fl. Males. ser. 1, 5: Figure 24 (1955).

Seedlings and juveniles: seedling leaves simple, entire (D. Foreman pers. comm.); juveniles not known.

Adults: trees to 30 m high and 0.85 m d.b.h., sometimes slightly buttressed. *Bark* grey to brown, reticulately and shallowly fissured. *Hairs* minute, to 0.1 mm, ferruginous, mostly appressed, straight. *Young branchlets* sparsely to moderately hairy, soon glabrescent. *Leaves* simple, entire, 5–16 cm long, 25–50 mm wide, discolorous, chartaceous; petiole 15–30 mm long, sparsely hairy when immature, glabrescent when mature; lamina elliptical to obovate to narrow-elliptical to narrow-obovate, forming angle of 45–75 degrees at base, rounded to obtuse, with flat to slightly recurved margins, sparsely hairy when very immature, soon glabrescent; venation brochidodromous, with secondary veins diverging at 40–70 degrees; midvein protruding slightly on adaxial surface and prominently on abaxial surface; lower order veins sunken. *Conflorescences* (2–)10–50-flowered, mostly axillary or ramiflorous, basitonic, mostly aggregated in superconflorescences of 2–8 at ends of branches, strongly asymmetrical, pedicels curved so that all flowers are similarly oriented on same side of conflorescence axis; axis moderately to densely hairy; bracts of flower-pairs triangular to narrow-triangular to -oblong, usually caducous. *Flowers* pinkish red to bright red; pedicels 20–35

mm long, moderately hairy; perianth 40–50 mm long, broadest below middle and tapering slightly to ends of claw, sparsely to moderately hairy on outside; pollen yellow; style c. as long as gynophore. Body of follicle 8–14 cm long; seeds 8–14.

FLOWERING PERIOD: June to October.

DISTRIBUTION AND HABITAT: Southern New Guinea; Upper Merauke River, Lower Fly River, Oriomo River and Aru Islands (Figure 3). At low altitudes on inland ridges or high banks of rivers not subject to inundation, usually in gallery rainforest but also recorded from bamboo–eucalypt forest (Sleumer 1955).

CONSERVATION STATUS: Not known; it is widespread in a relatively remote and undeveloped area of New Guinea.

SELECTED SPECIMENS (15 examined): PAPUA NEW GUINEA: Western District: Bensbach Sub-district, near Weam, 8°38'S, 141°07'E, *Ridsdale & Galore NGF 33737*, 16 Aug 1967 (CANB, BRI, NSW); Daru Subdistrict, near Woroi village on Oriomo River, 8°50'S, 143°07'E, *Foreman & Stocker NGF 60384*, 15 Jul 1974 (BRI, CANB, NSW, QRS); Morehead Subdistrict, ¼ mile [0.5 km] E of Karaita Village, 9°00'S, 141°25'E, *Eddowes & Kumul NGF 36046*, 17 Aug 1968 (BRI, CANB, NSW). INDONESIA: Irian Jaya: Bade, *Bouman BW 3223*, – (CANB).

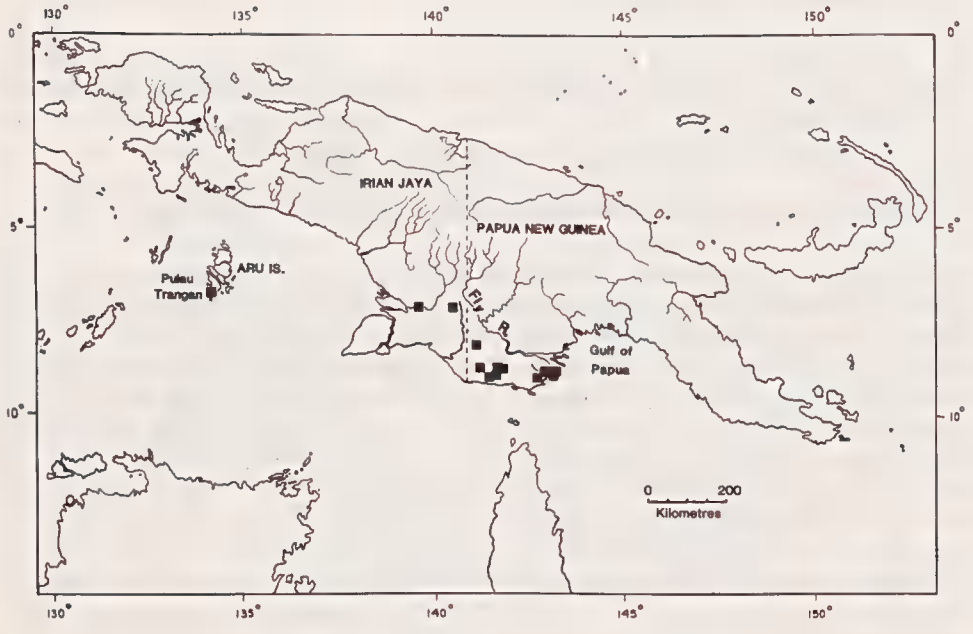

Figure 3. Distribution of *A. brachycarpum*.

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References

Chattaway, M.M. (1948) The wood anatomy of the Proteaceae. *Austral. J. Sci. Res. (B)* 1: 279–302.

Hickey, L.J. (1973) Classification of the architecture of dicotyledonous leaves. *Amer. J. Bot.* 60: 17–33.

Johnson, L.A.S. & Briggs, B.G. (1963) Evolution in the Proteaceae. *Austral. J. Bot.* 11: 21–61.

Johnson, L.A.S. & Briggs, B.G. (1975) On the Proteaceae – the evolution and classification of a southern family. *Bot. J. Linn. Soc.* 70: 83–182.

Sankowsky, G., Sankowsky, N., Radke, P. & Radke, A. (1986) *A field guide to the rainforest Proteaceae of north Queensland*, edn 1 (The authors: Tolga)

Stearn, W.T. (1973) *Botanical Latin*, edn 2 (David & Charles: Newton Abbot)

Sleumer, H. (1954) Proteaceae Americanae. *Bot. Jahrb. Syst.* 76: 139–211.

Sleumer, H. (1955) Proteaceae. *Flora Malesiana* ser. 1, 5: 147–206.

Weston, P.H. & Crisp, M.D. (1987) Evolution and biogeography of the Waratahs. In J.A. Armstrong (ed.), *Waratahs: their biology, cultivation and conservation.* Australian National Botanic Gardens Occasional Publication No. 9.

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A re-examination of the genus *Cheilanthes* (Adiantaceae) in Australia

T.C. Chambers and P.A. Farrant

Abstract

Chambers, T.C. & Farrant, P.A. (Royal Botanic Gardens, Sydney, NSW. Australia) 2000) 1991. A re-examination of the genus Cheilanthes *(Adiantaceae) in Australia.* Telopea *4(3): 509–557.* The taxonomy of the Australian species of *Cheilanthes* has been further revised following the availability of a much greater number of specimens, especially from northern Australia, since the revision of this genus in Australia by Quirk et al. in 1983. We describe one new species (*C. adiantoides*) and recognise 14 other species, one of which has two subspecies. Two of the 15 taxa recognised by Quirk et al. are reduced to synonymy. We clarify the taxonomy of the northern Australian species, and recognise one of the four species described recently by D.L. Jones. Two of the three taxonomic changes proposed by P.S. Green in 1988, one new combination and one change of authority, are accepted. Scatter diagrams are used to compare characters of specimens in what are believed to be closely related taxa. The distribution of each species is mapped and a key for their identification provided. The diagnostic characters found to be most useful for separating the Australian *Cheilanthes* were the degree of frond division, and the length and density of hairs and scales, on stipe, rhachis and upper and lower pinnule surfaces; spore characters were useful for some but not for all species. Although the breeding behaviour of *Cheilanthes* was not investigated per se in this study, new data on variability in spore number and spore size suggest that both hybridisation and apomixis are occurring in some populations and variation from hybridisation is contributing to the difficulty of defining some species.

Introduction

Examination of a much wider range of specimens from Australian herbaria, as well as specimens from elsewhere (including many type specimens), has enabled us to further revise the taxonomy of the Australian species of *Cheilanthes*, following on from the publication of Quirk et al. (1983). One new species is described (*C. adiantoides*) and fourteen other species are recognised, one of which (*C. sieberi*) has two subspecies. Of the fifteen taxa recognised by Quirk et al. (1983), two (*C. shirleyana* and *C. nudiuscula*) have been reduced to synonymy (with *C. tenuifolia* and *C. hirsuta* respectively), while one of the two Species Dubiae in Quirk et al. (1983) (*C. prenticei*) is recognised, and the other (*Cheilanthes* sp.) is placed in *C. caudata*. Only one (*C. praetermissa*) of the four new species described by D.L. Jones (1988) is accepted, and Jones' new combination of *C. pseudovellea* is not accepted. Of the three taxonomic changes proposed by P.S. Green (1988), one new combination (*C. nitida*) and one change of authority (for *C. brownii*), are accepted. The change of name proposed for *C. sieberi* is not substantiated.

The cytology of *Cheilanthes* was not further investigated. Nevertheless, the spore numbers in the sporangia (16 and 32) and the spore sizes (very large in the case of the 16-spored sporangia) are strong evidence of obligate apomixis occurring widely in the Australian species of *Cheilanthes*. The 32-spored sporangia may be the result of the 'normal' type 'Döpp-Manton' sequence (see Walker 1979 for discussion) where after four mitotic divisions of the archesporium, in one of which the cells fail to divide, eight spore mother cells are produced; the subsequent meiotic divisions result in 32-spored sporangia. The 16-spored sporangia contain 16 large spores as well as 16 minute aborted spores, suggesting that an uneven division is taking place. Four taxa,

Cheilanthes sieberi subsp. *sieberi*, *C. caudata*, *C. pumilio* and *C. brownii*, exhibit both 32- and 16-spored individuals. This suggests a complex pattern of evolution that is not fully understood at present.

The genus *Cheilanthes* has been variously placed in the Polypodiaceae (Christensen 1906), the Pteridaceae (Copeland 1947), the Sinopteridaceae (Pichi-Sermolli 1970, 1977), and the Adiantaceae (Mickel 1987). We have accepted that *Cheilanthes* belongs to the Adiantaceae.

Neurosoria, a monotypic genus created by Mettenius in 1869 for a single Australian species which he had removed from *Acrostichum*, cannot be separated from *Cheilanthes*. *A. pteroides* was placed in the genus *Cheilanthes* by Quirk et al. (1983) under *C. tenuissima* (*C. nitida* in this paper). The genus *Cheilanthes* appears to be closely allied to the genus *Notholaena*. *Cheilanthes fragillima*, for example, originally described by Hooker as *Notholaena fragilis*, has sori not sufficiently confluent to place it in *Notholaena*. *Notholaena* is now considered to be an American genus, with no representatives in Australia (Tryon & Stolze 1989). Two species of *Cheilanthes* in Australia (*C. nitida* (R. Br.) P.S. Green and *C. praetermissa* D.L. Jones) superficially resemble species in *Mildella* (*M. leonardii* and *M. intramarginalis*), a genus not found in Australia. Some authors (Tryon & Stolze 1989) place *Mildella* in synonymy with *Cheilanthes*. Comparison of *Cheilanthes* from Australia with American specimens of *Mildella*, however, indicates that the two genera are distinct. *Cheilanthes nitida* and *C. praetermissa* do not possess either the marginal flange or the inframarginal indusium characteristics of the genus *Mildella*. *Cheilanthes praetermissa* also bears a superficial resemblance to *Doryopteris concolor* (Langsd. & Fischer) Kuhn; *Doryopteris*, however, is characterised by a simple or palmatifid lamina.

We have only included synonyms based on Australian types in this publication. Full synonymies can be found in Quirk et al. (1983). Full details for specimens cited in the figures can be found under 'Selected Specimens' of the appropriate taxon; all such specimens are from NSW unless otherwise indicated.

Diagnostic characters

Identification of Australian species of *Cheilanthes* is not always easy. A 10x hand lens will not usually be powerful enough for examining the hair and scale characteristics and certainly is not adequate for spore characteristics or counts. The dendritic nature of some hairs and scales, for example, can only be observed by removing and examining individual hairs or scales under a dissecting microscope. The diagnostic characters that were found to be most useful for the Australian *Cheilanthes* were length and density of hairs and scales, on stipe, rhachis and upper and lower pinnule surfaces, and the degree of frond division; spore characters were useful for some, but not all, of the species. The hair and scale distribution for upper and lower pinnule surfaces and for stipe or rhachis, for each Australian taxon, is shown in Figures 1–4. The salient characters of the Australian taxa are summarized in Table 1. As well, many useful figures, including figures of type specimens, will be found in Quirk et al. (1983).

The hairs found on the Australian species of *Cheilanthes* are of two forms: simple hairs, i.e. elongate unbranched (most species, see Figures 17d, 19e) or, rarely, with a single branch (Figure 13j); and multi-branched hairs, i.e. dendritic compound trichomes (only in one species, *C. lasiophylla*, see Figure 18f). The hairs vary in length, from minute (< 0.2 mm) to short (0.2–0.5 mm) to medium (0.5–1.0 mm) to long (>1.0 mm). The hairs vary in rigidity and this is not dependent on their length, for example the minute hairs of

C. contigua, the short hairs of *C. tenuifolia* and *C. contigua* and the medium to long hairs of *C. fragillima* are all rigid. Apart from these species, however, the rigidity of hairs may not be consistent even on any one specimen. The hairs on *Cheilanthes* vary in straightness: the rigid hairs tend to be straight, long weak hairs tend to curl and can form a dense tangled mass as in *C. brownii*, while the hairs of *C. sieberi* subsp. *pseudovellea* are quite twisted. Rigid straight hairs tend to be erect, while weak hairs tend to be spreading. Glandular hairs are found on several species (Figure 13j). Hairs may have blunt apices or they may taper to a point. Hairs are usually uniseriate, though occasionally they may be two cells broad at the base. Scales have multiseriate bases and taper to an apex, sometimes with protuberances along their margins (Figures 13e, 17e, 19f); in one species, *C. lasiophylla*, the scales have dendritic bases (Figure 18g). In some species the scales are densest at the junctions of stipe, rhachis and rhachillas (Figure 1d).

The range of hair density found in the Australian *Cheilanthes* can best be seen on the following figures: absent/glabrous (Figure 1c), sparse (Figure 2a), moderately dense (Figure 2c), and dense (Figure 4b). Hairs may be denser at the margins (Figure 3d).

Spores

Scanning electron micrographs of spores of all the Australian *Cheilanthes* species are presented in Figures 5–8.

All spores examined in this study were from herbarium specimens. Sporangia were selected from sori which appeared mature. Spores were mounted on double-sided sticky tape on stubs, coated with gold in a sputter coater and examined under a scanning electron microscope. All spores were photographed at the same magnification and measured along their diameter (round spores) or across the surface in line with one of the axes of the trilete mark (tetrahedral spores). Measurements of single spores from different specimens (and different collections) were used in calculating average spore size for a species.

The spore sizes reported in this study indicate some differences from those given by Quirk et al. (1983). In both studies the spores were measured from scanning electron micrographs. Differences in the lower limit of the spore size given in the two publications are probably the result of minor differences in the maturity of spores (although seemingly mature sporangia were chosen for both studies). In general the upper limit of the spore size has been extended in this new study because of the greater range of specimens available. In the case of several species there is significant new information on the spores.

C. sieberi subsp. *sieberi*. Although Quirk et al. (1983: 519) gave two spore size ranges for this species, they omitted to mention that these two groups have different spore counts: plants either have 32 smaller spores per sporangium (Figure 5c,d) or 16 larger spores per sporangium (Figure 5a,b).

C. sieberi subsp. *pseudovellea*. Although the scale on the micrograph of the spore in Quirk et al. (1983: Figure 37) gives the correct size, the spore size of 32 µm diam. in the text (1983: 522) is in error. This subspecies has large verrucate spores, with an average diameter of 60.6 µm (n=33 spores) (Figure 5e).

C. fragillima. Both the spore size range of 22–25 µm diam. and the number of spores per sporangium (16) given by Quirk et al. (1983: 525) are incorrect, although the spore micrograph scale gives the correct spore size (Figure 39 in Quirk et al.). Most specimens of this species have spores already shed, and so these figures may reflect a

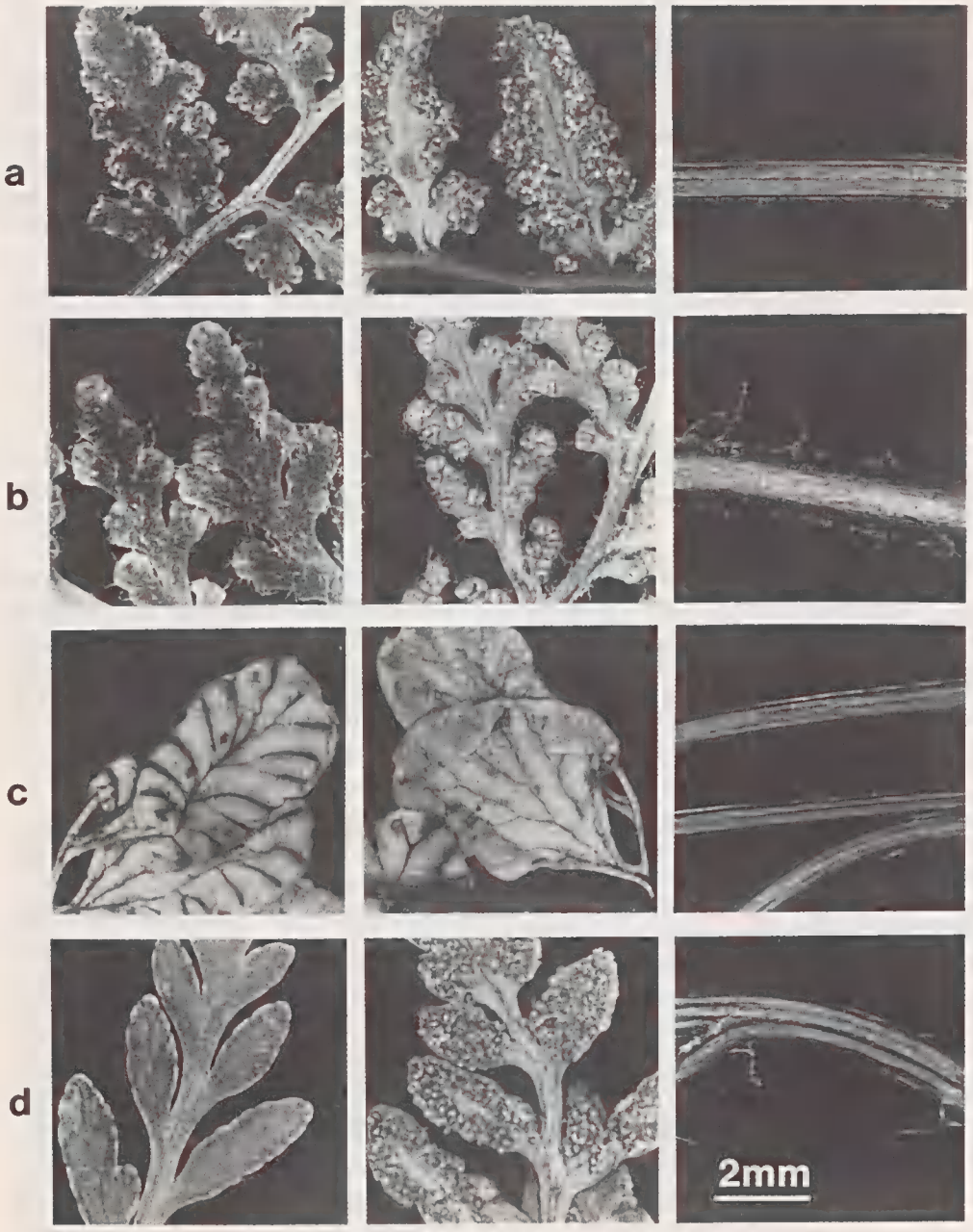


Figure 1. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW) from left to right: upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe; all to same scale: **a, *C. sieberi* subsp. *sieberi*:** upper and lower pinnule surfaces: *Boorman*, NSW 192555; stipe: *Beauglehole 20266*; **b, *C. sieberi* subsp. *pseudovellea*:** upper and lower pinnule surfaces: *Nelson 1745*; stipe: *Coveny 544*; **c, *C. adiantoides:*** *Chinnock 5274*; **d, *C. austrotenuifolia*:** upper and lower pinnule surfaces: *Helms*, NSW 192117; stipe: *Wilson 1870*.

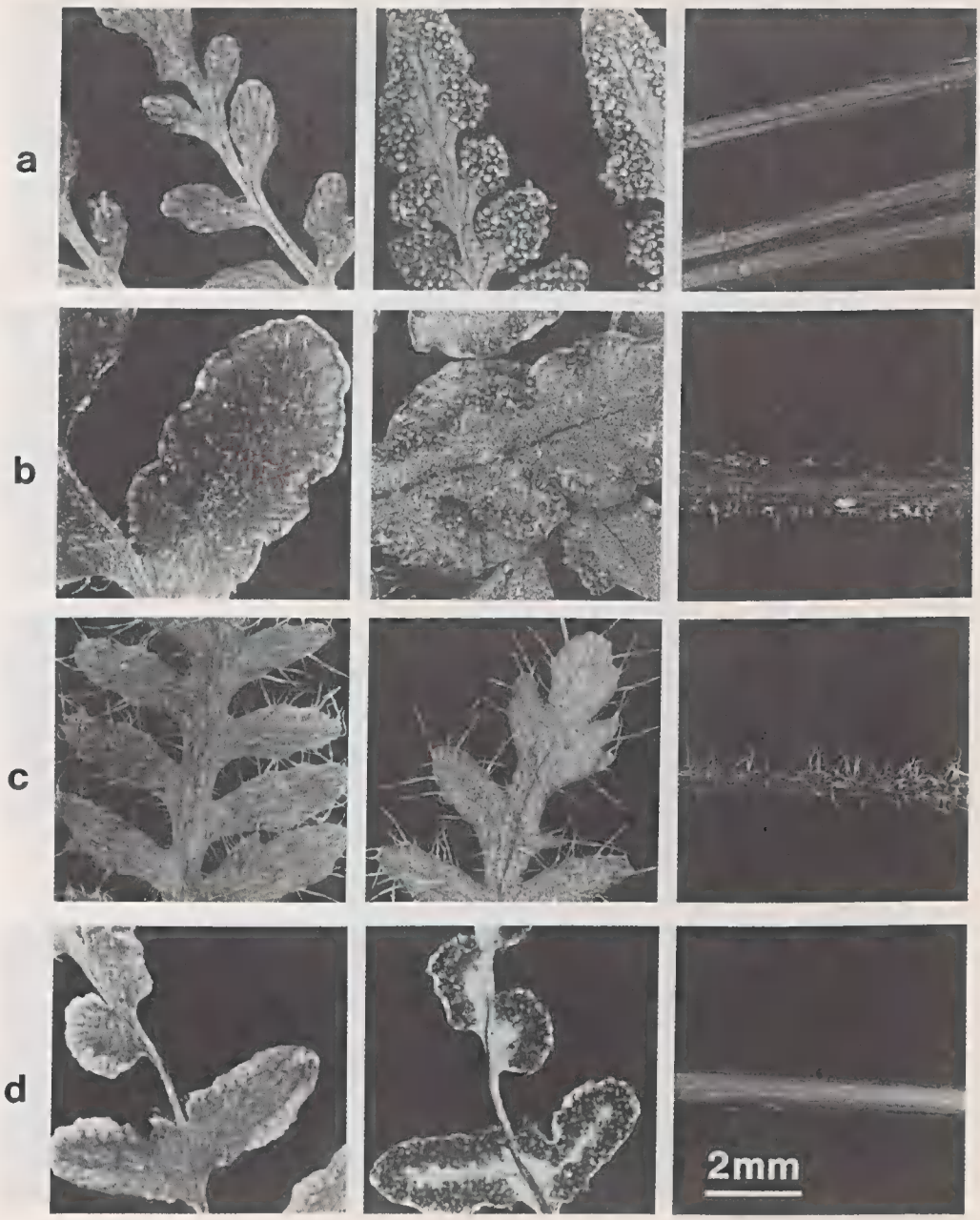


Figure 2. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW): upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe (a, b, d) or rhachis (c); all to same scale: **a, *C. tenuifolia*:** upper pinnule surface and stipe: *Messmer*, NSW 192452; lower pinnule surface: *Waller*, NSW 199183; **b, *C. contigua*:** *Brown*, NSW 199026; **c, *C. fragillima*:** *Pullen 9443*; **d, *C. caudata*:** *Jones 1549*.

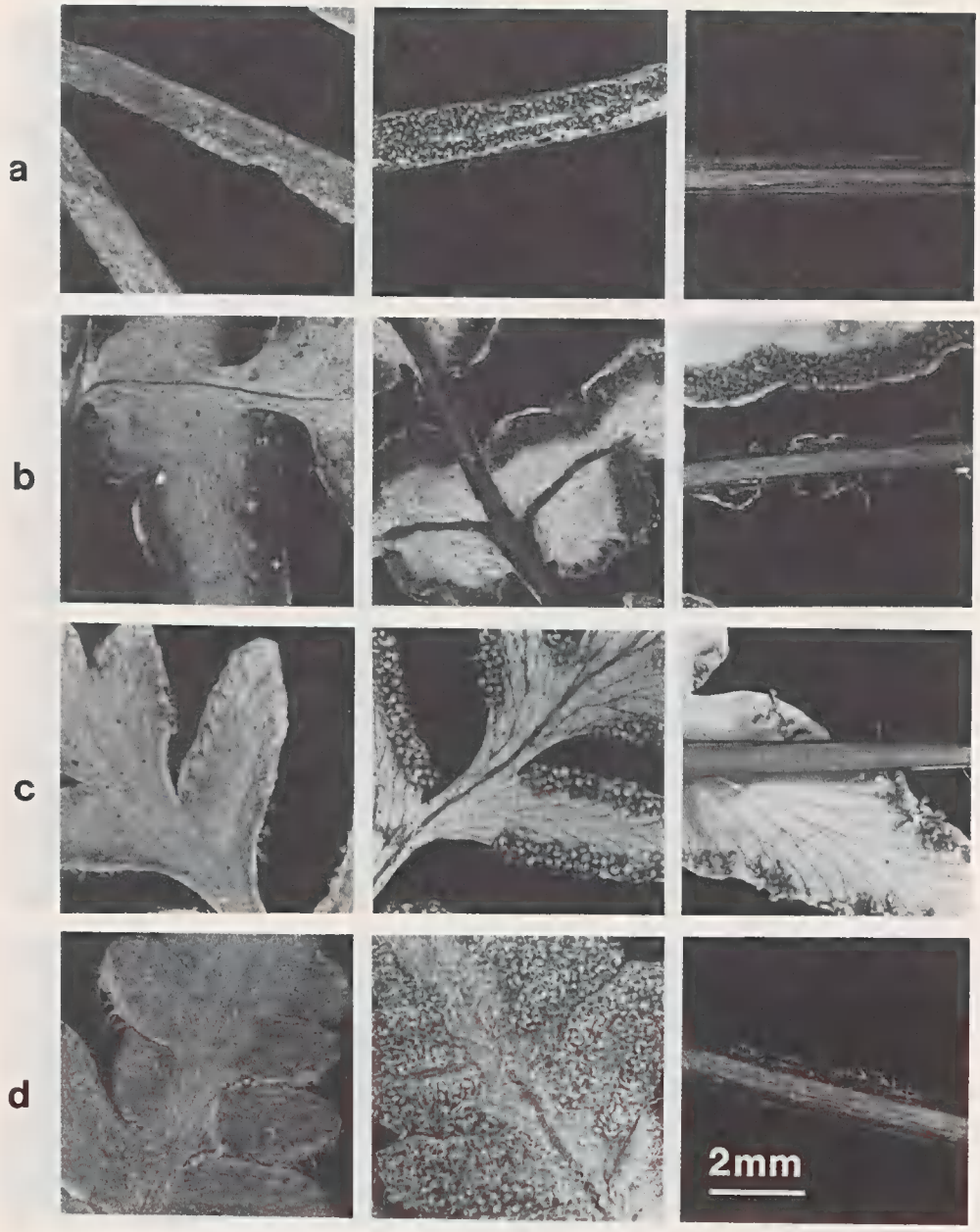


Figure 3. Hair and scale characteristics of *Cheilanthes* species: upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe; all to same scale: **a, *C. nitida*:** *McKee 9271*; **b, *C. praetermissa*:** *M. Lazarides 7876*; **c, *C. pumilio*:** *Tindale 6054*; stipe: *Wood R790396a*; **d, *C. prenticei*:** upper and lower pinnule surfaces: *Tate*, BRI 314663; stipe: *Young*, BRI 314659.

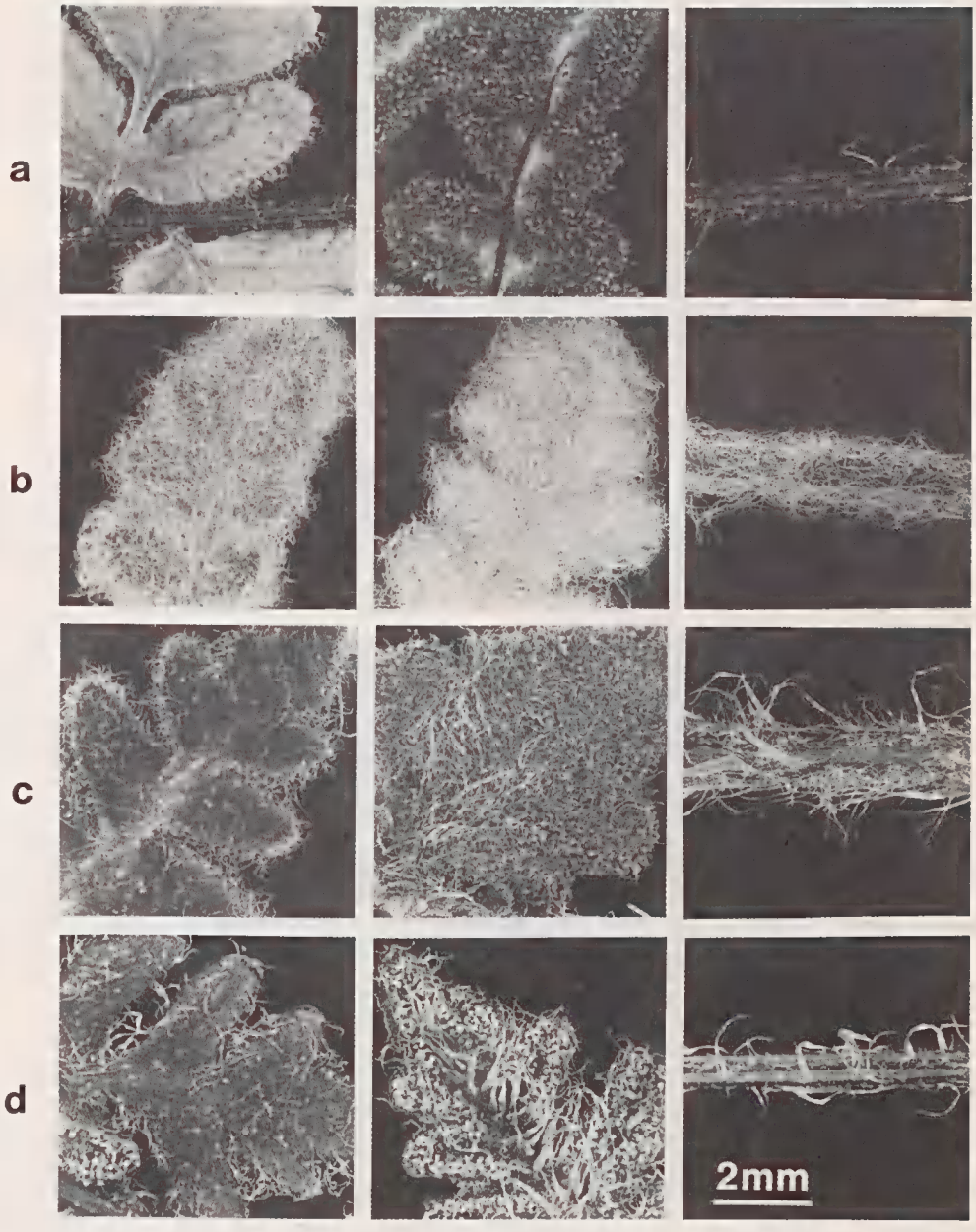


Figure 4. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW): upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe (a, c, d) or rhachis (b); all to same scale: **a, *C. hirsuta*:** *A. Tryon 7346 & R. Tryon;* **b, *C. brownii*:** *Swinbourne 685;* **c, *C. lasiophylla*:** upper pinnule surface and stipe: *Learmouth ACB 7568;* lower pinnule surface: *Constable,* NSW 192214; **d, *C. distans*:** upper and lower pinnule surfaces: *Chinnock 204;* stipe: *Morrow 42.*

Table 1. Salient characters of Australian *Cheilanthes* taxa (glab. = glabrous; mod. = moderately dense; esp. = especially)

Species and spore number	Frond division at base	Stipe	Rhachis and rhachillas	Upper pinnule surface	Lower pinnule surface	Other features
sieberi subsp. *sieberi* 16 (32)	3-pinnate	glabrous or sparse to mod. hairs & scales	glabrous or sparse to mod hairs & scales	glabrous	glabrous or very sparse hairs	lamina linear-lanceolate or ovate
sieberi subsp. *pseudovellea* 16	3-pinnate	glabrous or sparse to mod. hairs & scales	mod. to dense long twisted hairs	sparse to mod. long twisted hairs	sparse to dense long twisted hairs	lamina linear-lanceolate or ovate
adiantoides 32	3-pinnate or 2-pinnate	glab. or sparse hairs & scales esp. junctions	sparse hairs & scales densest at junctions	glabrous	glabrous	lamina ovate; infolded fertile pinnules
austrotenuifolia 32	4-pinnatifid or 3-pinnate	glabrous or sparse hairs and scales	sparse to mod. scales & hairs esp. junctions	glabrous	sparse hairs & scales esp. on midribs	lamina deltoid, elliptic, ovate or lanceolate
tenuifolia 32	4-pinnate or 3-pinnate	glabrous or sparse hairs and scales	glabrous or sparse hairs and scales	very sparse short acute hairs	sparse short hairs esp. on midribs	lamina pentagonal, deltoid or ovate
contigua 32	4-pinnate or 3-pinnate	glab. or sparse to dense short hairs; few scales	mod. to dense short hairs; sparse scales	sparse to dense minute or short hairs	sparse to dense hairs esp. on midribs	lamina deltoid, elliptic or ovate
fragillima 32	4-pinnate or 3-pinnate	glabrous	sparse to mod. straight acute hairs	sparse long straight hairs esp. margins	sparse long straight hairs	lamina deltoid or ovate
caudata 32 (16)	3-pinnate or 4-pinnatifid	glabrous or sparse hairs	glabrous or sparse hairs	glabrous or sparse short *or minute hairs*	glabrous or sparse short or minute hairs	lamina ovate or deltoid; caudate at extremities

Species and spore number	Frond division at base	Stipe	Rhachis and rhachillas	Upper pinnule surface	Lower pinnule surface	Other features
nitida 32	2-pinnate (3-foliolate inner pinnule)	glabrous or sparse hairs	glabrous or sparse hairs	glabrous or minute rigid hairs	glabrous or short hairs on midrib	lamina ovate or oblong; long linear pinnules
praetermissa 32	2-pinnate or 3-pinnatifid	glabrous or sparse hairs and scales	glabrous or sparse hairs and scales	glabrous or sparse short hairs	glab. to sparse hairs esp. on midribs	lamina deltoid; midribs dark for part of length
pumilio 32 (16)	1-pinnate to 3-pinnate	glab. or sparse to mod. hairs; sparse scales	glab. or sparse to mod. hairs; sparse scales	glab. or sparse to dense hairs esp. margins	glab. or sparse to dense hairs, esp. midribs	lamina deltoid or ovate; membranous
prenticei 32	2-pinnate or 3-pinnate	glab. or sparse to dense hairs; sparse scales	mod. to dense short to medium hairs	glab. or sparse to mod. hairs, esp. margins	mod. to very dense hairs	lamina elliptic, ovate or lanceolate; somewhat caudate
hirsuta 16	2-pinnate or 3-pinnate	glabrous or sparse hairs; sparse scales	sparse to mod. hairs; sparse scales	sparse hairs esp. at margins, or rarely glabrous	sparse to dense hairs	lamina elliptic or lanceolate; pinnules obtuse or acute
brownii 16 (32)	2-pinnate or 3-pinnate	sparse to dense long fine hairs; sparse scales	sparse to dense long fine hairs; sparse scales	sparse to very dense long fine hairs	extremely dense long fine hairs	lamina elliptic or lanceolate; pinnules rounded
lasiophylla 16	2-pinnate	mod. to dense branched scales	mod. to dense branched scales	sparse to mod. branched hairs	dense branched hairs; sparse scales	lamina elliptic or lanceolate; scales & hairs branched
distans 16	2-pinnatifid or 2-pinnate	mod. to dense scales; sparse hairs	dense scales	sparse to mod. hairs; very sparse scales	sparse to dense scales; very sparse hairs	lamina linear

difficulty in obtaining full, mature sporangia. *C. fragillima* has 32 spores per sporangium and a spore size range of 41–50 µm diam. (*n*=5) (Figure 6e).

C. pumilio. The spore size of 24 µm diam. given by Quirk et al. (1983: 533) is incorrect. Furthermore the present study has shown that *C. pumilio* can have either 32 spores (33–50 µm diam.) (Figure 7d–f) or 16 spores (50–68 mm diam.) (Figure 7g,h) per sporangium and that the type material of *C. pumilio* has 16 spores per sporangium rather than 32 as was originally thought by Quirk et al. (1983).

C. brownii. This study has shown that *C. brownii* can have either 32 spores (34–48 µm diam.) (Figure 8f,g) or 16 spores (47–71 µm diam.) (Figure 8h) per sporangium.

Scatter diagrams

The following characters were examined in specimens of apparently closely related taxa (see Table 1): frond division, hair density and length for the stipe, rhachis, lower pinnule surface and upper pinnule surface.

Four character states were used for each, as follows:

Frond division: 1. pinnate 2. bipinnate 3. tripinnate 4. quadripinnate

Hair density: 1. absent 2. sparse 3. moderately dense 4. dense

Hair length: 1. minute (< 0.2 mm) 2. short (0.2–0.5 mm) 3. medium (0.5–1.0 mm) 4. long (≥ 1.0 mm)

These character states necessarily represent points on a continuum, with intermediate points on the scatter diagrams representing either averages for different parts of the plant, or in the case of frond division, states of bipinnatifid (1.5), tripinnatifid (2.5) and so on.

The scatter diagrams (Figures 9 & 10) summarize the character states for a number of taxa difficult to separate and allow comparisons to be made. The number of specimens examined for each taxon is given in the figure legends. Each dot on the figures represents a single herbarium specimen from a single collection, though the dot may also represent a number of specimens that have identical co-ordinates. In Figures 9 and 10 the values for stipe and rhachis hair density are averages of stipe hair density and rhachis hair density; likewise pinnule hair length and pinnule hair density are averages of the values for upper and lower pinnule surfaces. The conclusions drawn from the scatter diagrams are presented in the 'Notes' sections of the relevant taxa.

Cheilanthes

Cheilanthes Sw.
Swartz, Syn. Fil. 5: 126 (1806)

TYPE: *C. micropteris* Swartz

Neurosoria Mettenius, Bot. Zeitung (Berlin) 27: 437 (1869). HOLOTYPE: *N. pteroides* (R. Br.) Mettenius in Kuhn (*Acrostichum pteroides* R. Br.).

Ground ferns with shortly creeping horizontal scaly rhizomes. *Stipes* slender, ⅓ to 3 ½ times the length of the lamina. *Stipe, rhachis and rhachillas* glabrous to densely hairy and/or scaly. *Fertile and sterile fronds* produced, similar or dimorphous, erect or spreading. *Lamina* pinnate to quadripinnate at the base. Larger pinnae to 14-paired,

opposite to subopposite or alternate, petiolulate or subsessile, lowermost with basiscopic half equally or more developed than acroscopic. *Pinnules* sessile or with very short petiolules, surfaces glabrous to densely hairy and/or scaly. *Sori* marginal, discrete or continuous, often protected by the inrolled pinnule margin. *Spores* tetrahedral, rounded-tetrahedral or spherical, variously ornamented, 16 or 32 per sporangium.

Distribution and Habitat: A worldwide genus of at least 180 species with 15 representatives in Australia. Occurs throughout Australia, extending from areas close to the coast to inland regions of more severe aridity than any other fern genus can tolerate. It typically occurs in dry stony areas both in open woodlands and on exposed sites. Several taxa appear to be endemic to Australia: *Cheilanthes adiantoides, C. austrotenuifolia, C. brownii, C. caudata, C. fragillima, C. lasiophylla, C. nitida, C. praetermissa, C. pumilio, C. sieberi* subsp. *pseudovellea.* Three (*C. tenuifolia, C. contigua* and *C. hirsuta*) occur also in S.E. Asia, and two (*C. distans* and *C. sieberi* subsp. *sieberi*) in New Zealand and some Pacific islands. *Cheilanthes prenticei* is found in the Cape York area and on Thursday Island in the Torres Strait (Figures 11 & 12).

Species of *Cheilanthes* are often amongst the first green plants to show new growth in some of the rough pastoral country of Australia after drought, sometimes leading to poisoning of domestic stock that are not adapted to this food source.

Note: All the descriptions that follow the key, except that for the new species *Cheilanthes adiantoides,* contain only the relevant information that we believe to be necessary for identification of the Australian *Cheilanthes;* full descriptions of these species may be found in Quirk et al. (1983) and in Jones (1988). All types and other specimens referred to in this publication have been seen by one or both of the authors unless otherwise indicated.

[Key to species: see page 528]

Figure 5. (page 520) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). **a–d, *C. sieberi* subsp. *sieberi*:** a *D. Symon 76* (16-spored specimen), b *A.F. Davies & D. Errey ACB 20385* (16-spored specimen), c, d *G. Chippendale 3643* (32-spored specimen). **e, *C. sieberi* subsp. *pseudovellea*:** e *R. Coveny 567.* **f,g, *C. adiantoides*:** f *M.D. Tindale 2754,* g *R.J. Chinnock 5274* (type).

Figure 6. (page 521) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). **a,b, *C. austrotenuifolia*:** a *R. Helms,* NSW 192117, b *P.G. Wilson 1870.* **c,d, *C. tenuifolia*:** c *R.L. Specht 506,* d *S. Jacobs 5476 & J. Clarkson.* **e, *C. fragillima*:** *C. Dunlop 4445.* **f, *C. contigua*:** *S. Jacobs 5390 & J. Clarkson.* **g–i, *C. caudata*:** g *D.L. Jones 1478* (DNA) (*C. pinnatifida* type, 32-spored specimen), h *D.L. Jones 1549* (32-spored specimen), i *A. & R. Tryon 7344* (16-spored specimen).

Figure 7. (page 522) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). **a,b, *C. praetermissa*:** a *M.D. Tindale 10040 & P. Munns,* b *M. Lazarides 7876.* **c, *C. nitida*:** *S. Jacobs 5473 & J. Clarkson.* **d–h, *C. pumilio*:** d *Dunlop 5838* (DNA) (*C. dunlopii* type, 32-spored specimen), e *Henshall 1951 (DNA)* (*C. cavernicola* type, 32-spored specimen), f *W.W. Froggatt,* NSW 217223 (32-spored specimen), g *Banks & Solander,* NSW 192292 (fragment of holotype, 16-spored specimen), h *C.H. Gittins,* NSW 228462 (16-spored specimen).

Figure 8. (page 523) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). **a, *C. lasiophylla*:** *Hj. Eichler,* NSW 192190. **b, *C. distans*:** *D.F. Blaxell 522.* **c,d, *C. prenticei*:** c *Tate,* NSW 218102, d *Coppinger,* NSW 218097 **e, *C. hirsuta*:** *S.T. Blake 23391.* **f–h, *C. brownii*:** f *K.L. Wilson 5225* (32-spored specimen), g, *B. Maloney 5* (32-spored specimen), h *S. Jacobs 1567* (16-spored specimen).

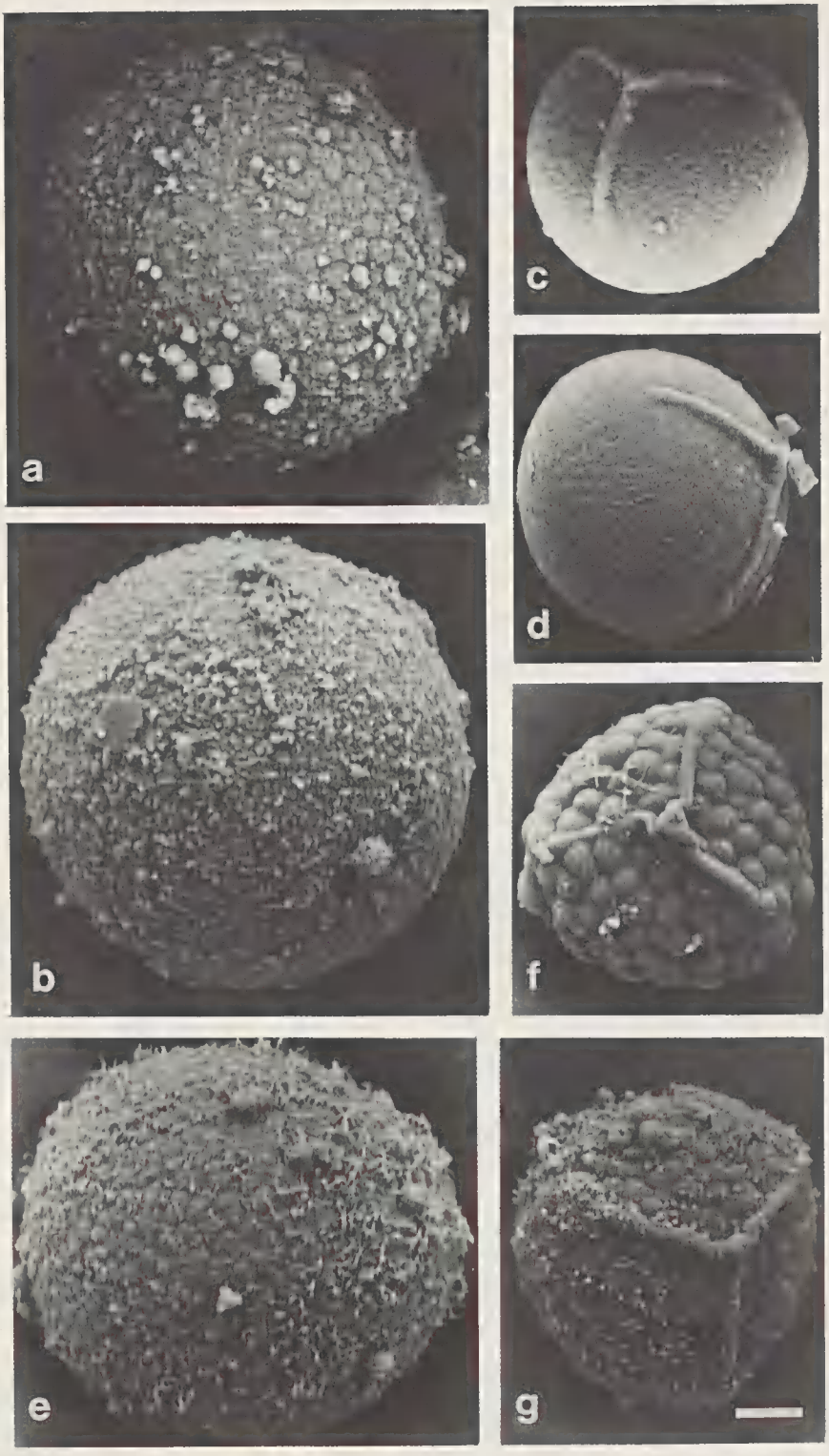
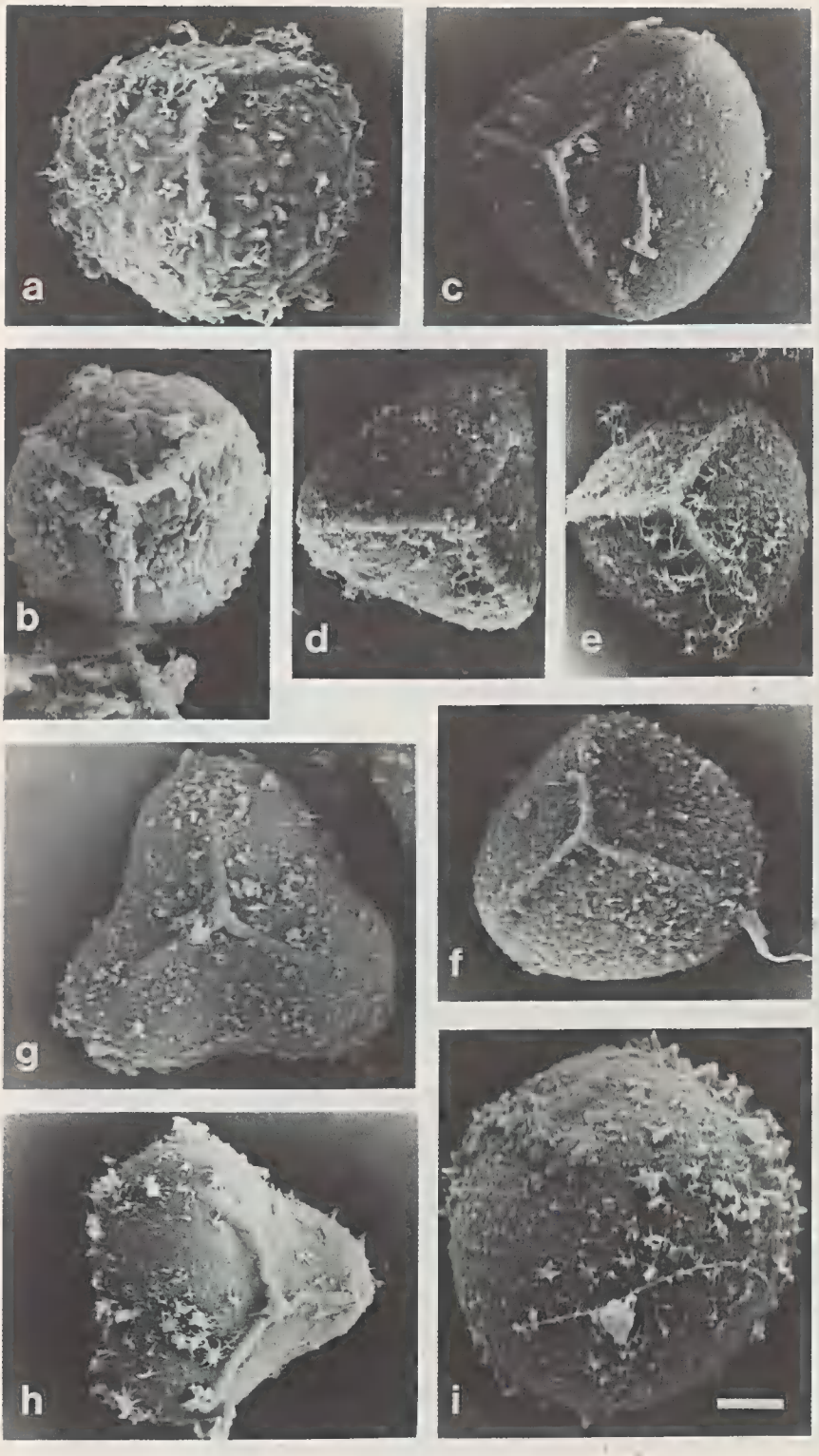


Figure 5.



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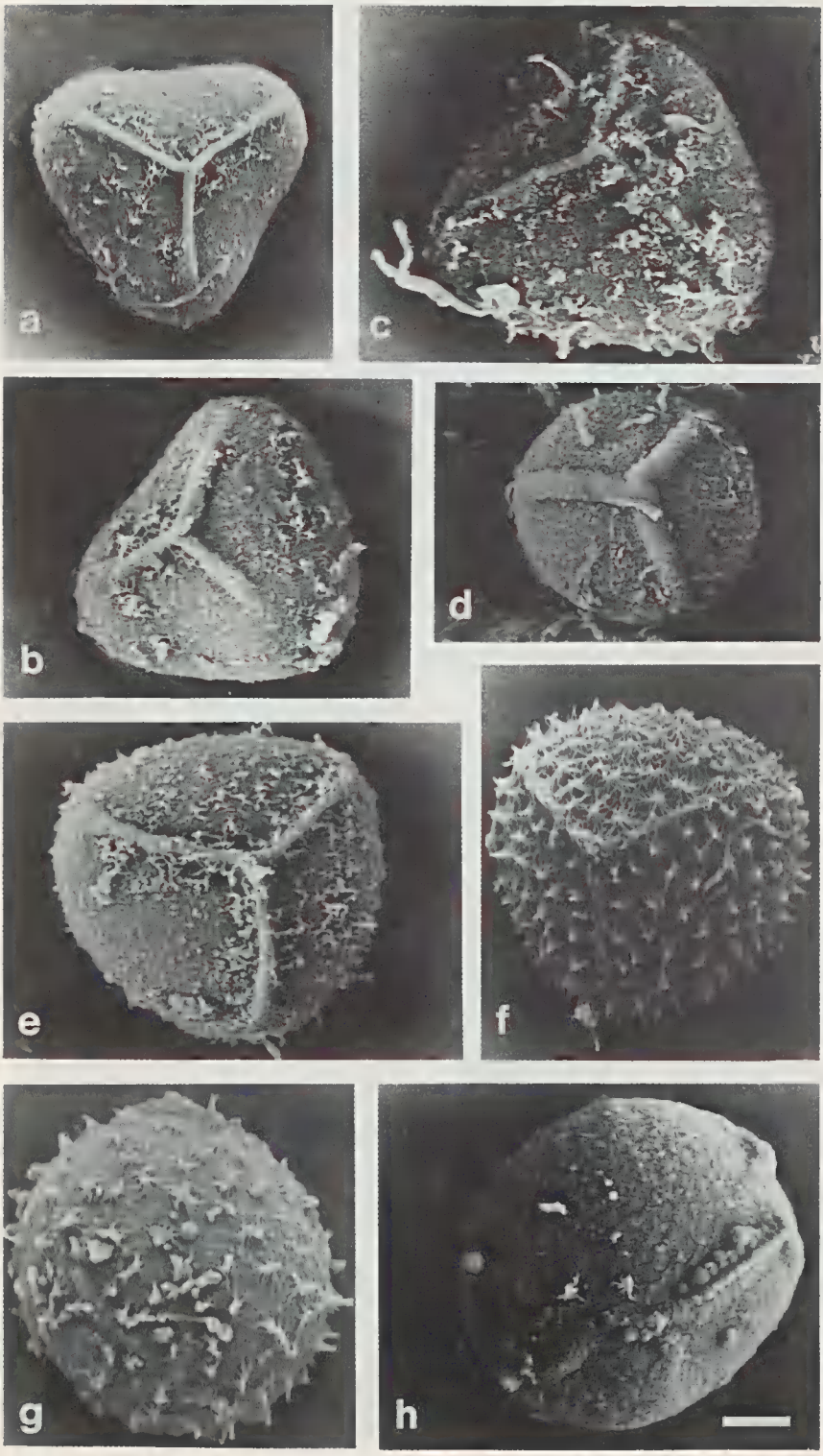

Figure 7.

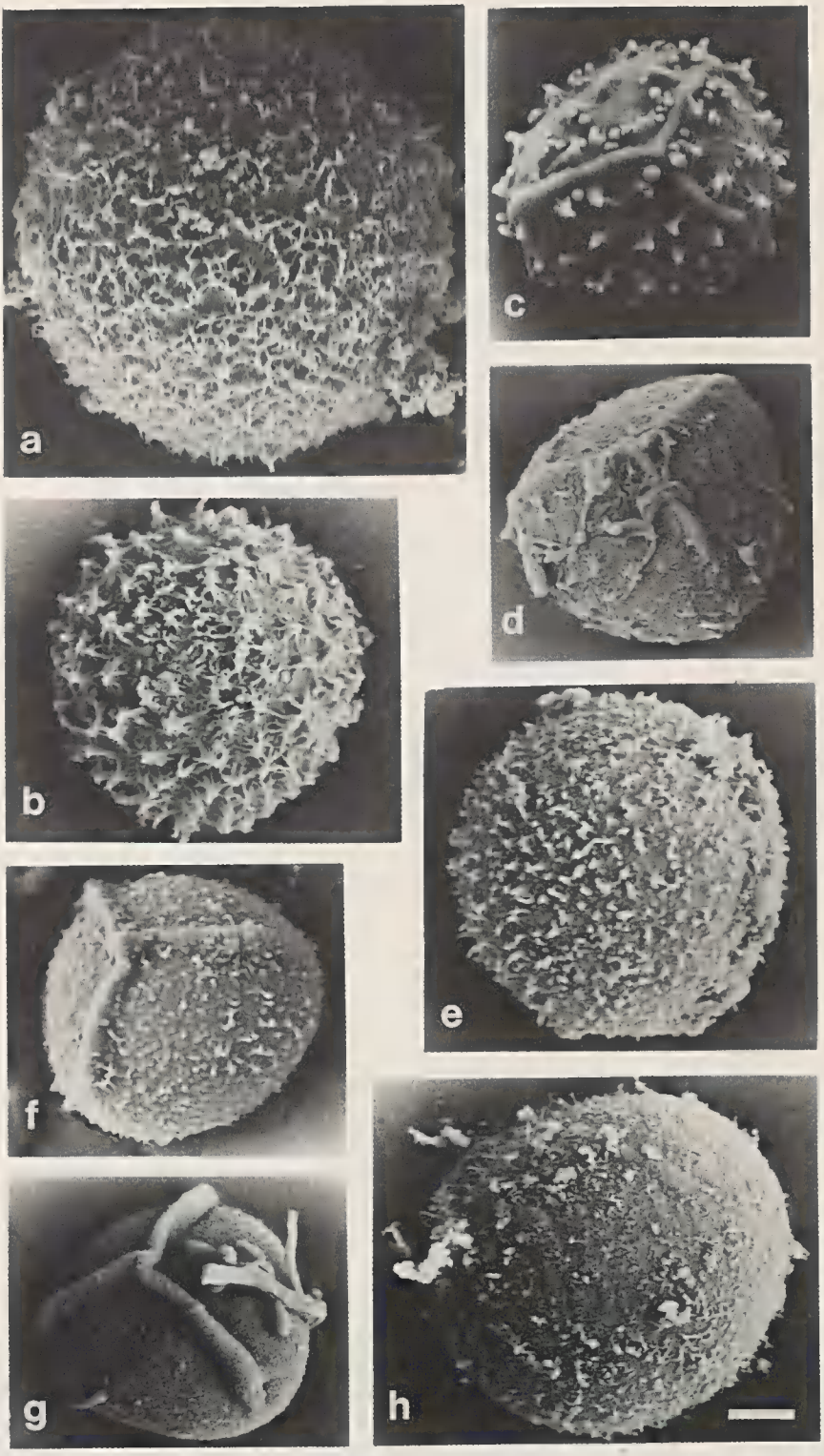

Figure 8.

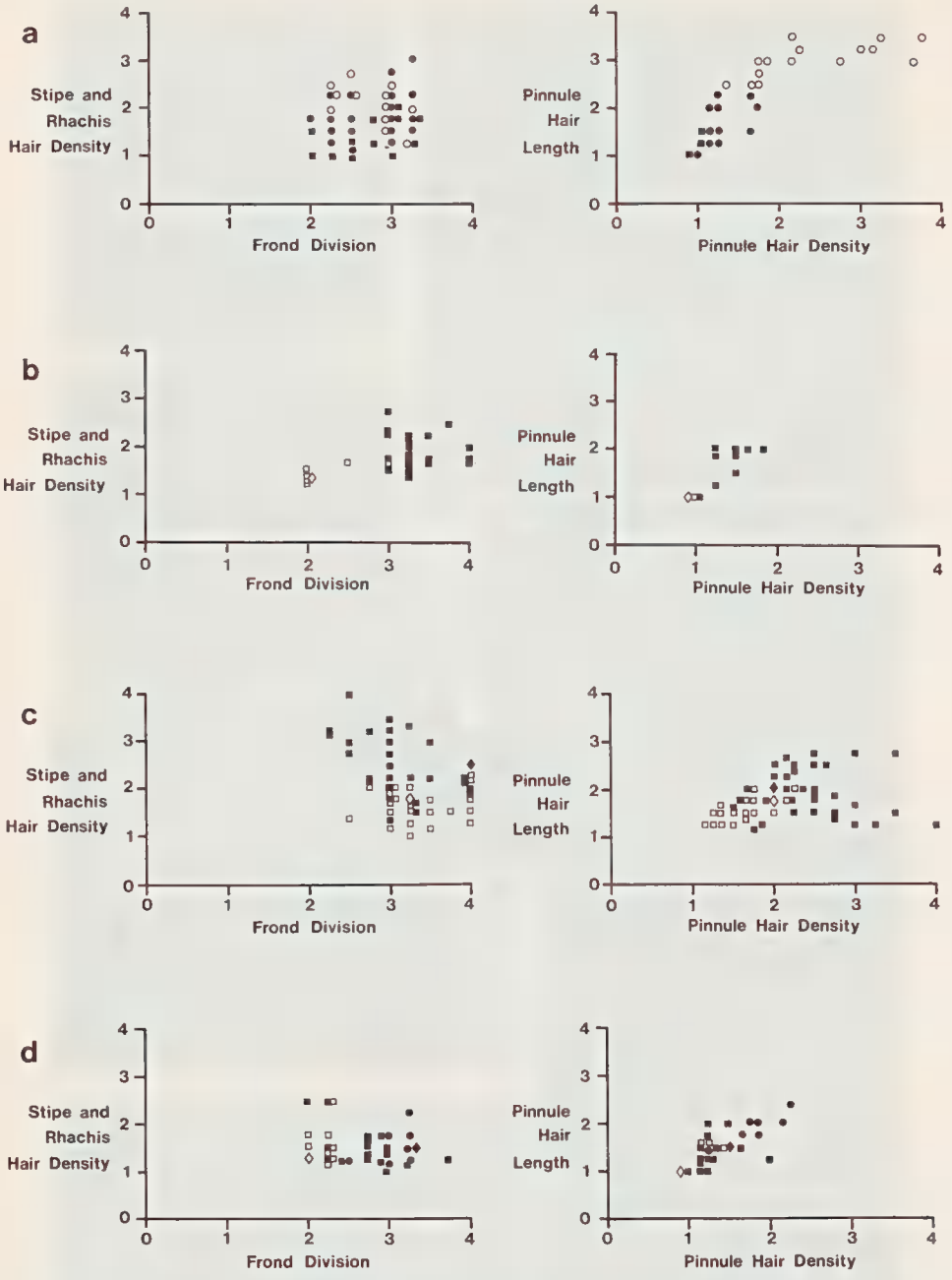

Figure 9. Scatter diagrams. *Frond division* vs *stipe and rhachis hair density* (left) and *pinnule hair density* vs *pinnule hair length* (right); circles represent 16-spored specimens, squares represent 32-spored specimens; diamonds represent type specimens: **a,** ***C. sieberi*** **subsp.** ***sieberi:*** 16-spored (closed circles; 28 specimens), 32-spored (closed squares; 17 specimens); ***C. sieberi*** **subsp.** ***pseudovellea*** (open circles; 17 specimens); **b,** ***C. adiantoides*** (open squares; 15 specimens; open diamond: type); ***C. austrotenuifolia*** (closed squares; 25 specimens); **c,** ***C. tenuifolia*** (open squares; 40 specimens; open diamond: type); ***C. contigua*** (closed squares; 38 specimens; closed diamond: type); **d,** ***C. caudata*****:** 16-spored (closed circles; 7 specimens), 32-spored (closed squares; 29 specimens; closed diamond: type); ***C. nitida*** (open squares; 14 specimens; open diamond: type).

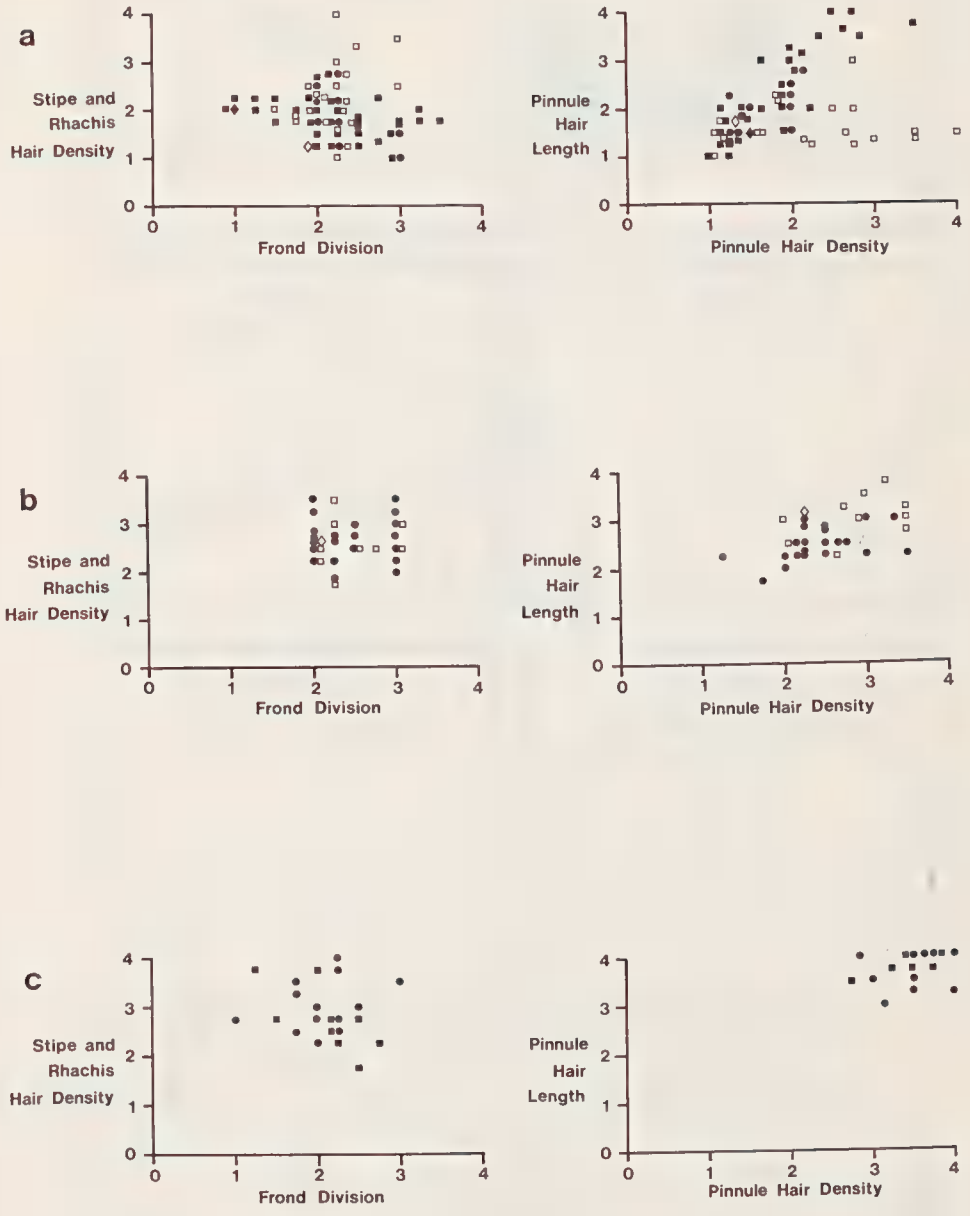

Figure 10. Scatter diagrams. *Frond division* vs *stipe and rhachis hair density* (left) and *pinnule hair density* vs *pinnule hair length* (right); circles represent 16-spored specimens, squares represent 32-spored specimens; diamonds represent type specimens: **a, *C. praetermissa*** (open squares; 12 specimens; open diamond: type); ***C. pumilio:*** 16-spored (closed circles; 11 specimens; closed diamond: type), 32-spored (closed squares; 47 specimens); **b, *C. prenticei*** (open squares; 12 specimens; open diamond: type); ***C. hirsuta*** (closed circles; 30 specimens); **c, *C. brownii*:** 16-spored (closed circles; 18 specimens), 32-spored (closed squares; 12 specimens).

Figure 11. Australian distribution of *Cheilanthes* species: **a,** *C. sieberi* subsp. *sieberi*; **b,** *C. sieberi* subsp. *pseudovellea*; **c,** *C. adiantoides*; **d,** *C. austrotenuifolia*; **e,** *C. tenuifolia*; **f,** *C. contigua*; **g,** *C. fragillima*; **h,** *C. caudata*.

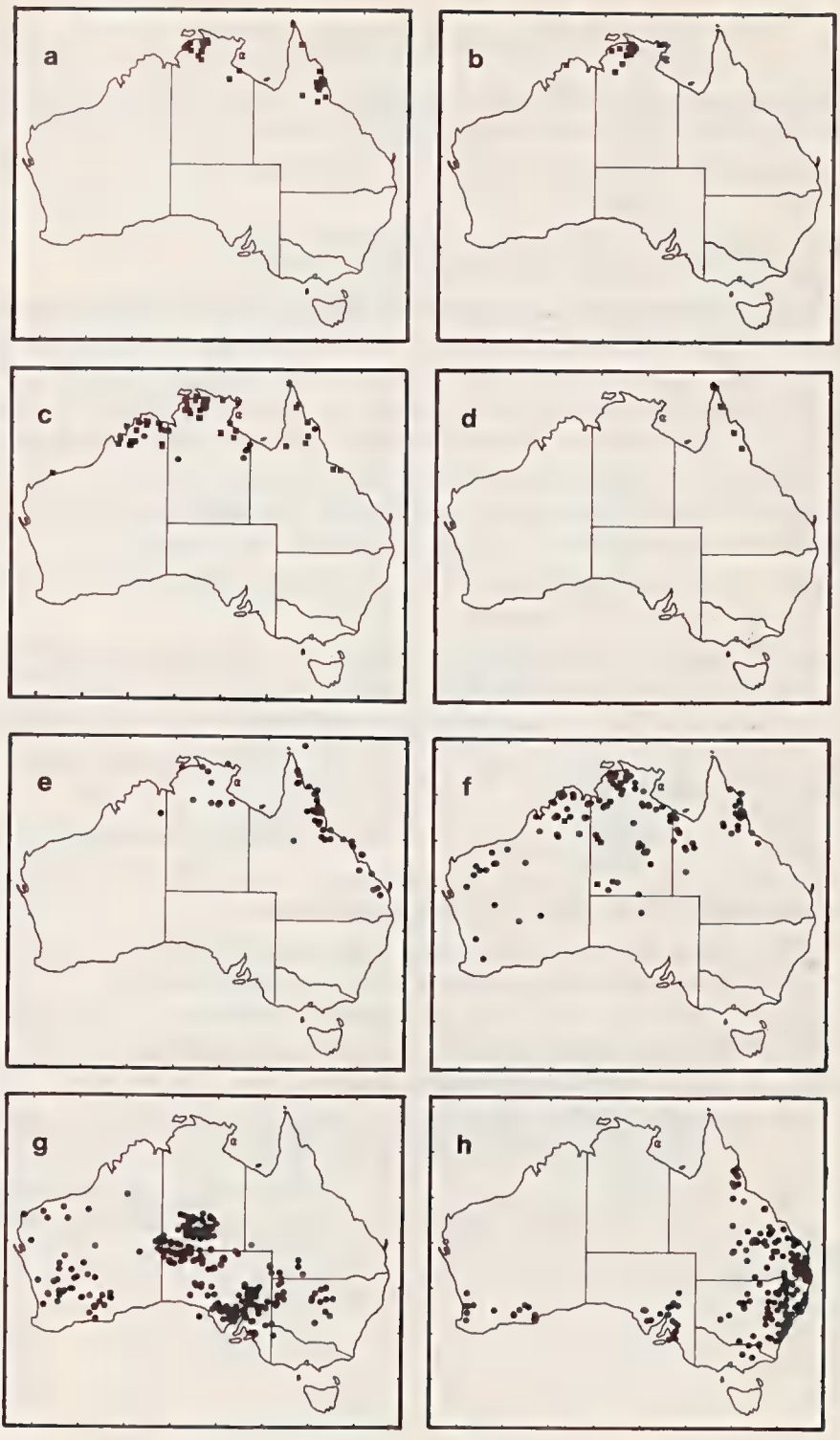

Figure 12. Australian distribution of *Cheilanthes* species: **a,** *C. nitida;* **b,** *C. praetermissa;* **c,** *C. pumilio;* **d,** *C. prenticei;* **e,** *C. hirsuta;* **f,** *C. brownii;* **g,** *C. lasiophylla;* **h,** *C. distans.*

Key to the species

1 Lamina linear and usually 1- or 2-pinnate at the base; more scaly than hairy, coarse scales at least on lower pinnule surface ..... **15. C. distans**

1* Lamina linear to deltoid and 1- to 4-pinnate at the base; glabrous, hairy or woolly, rather than scaly, though scales may be present

2 Ultimate pinnules linear and narrow (usually 0.5-2 mm) throughout lamina, at least five times longer than broad; usually glabrous

3 Ultimate pinnules at least ten times longer than broad; entire throughout; lamina 2-pinnate or sometimes with trifoliolate innermost pinnules at the base ..... **8. C. nitida**

3* Ultimate pinnules less than ten times longer than broad; with caudate tips and incised bases at lamina extremities; lamina 3- or 4-pinnate at the base ..... **7. C. caudata**

2* Ultimate pinnules not narrow, or if narrow then not linear, or less than five times longer than broad; glabrous, hairy or woolly

4 Lamina woolly with long hairs (usually > 1 mm) especially on lower surface; pinnules lacking marginal fringe of hairs

5 Scales abundant on stipe and rhachis; hairs and bases of scales branched (may need to remove one to see this) ..... **14. C. lasiophylla**

5* Few scales on stipe and rhachis; hairs and bases of scales not branched

6 Lamina 2- or rarely 3-pinnate at the base; pinnules deltoid and rounded ..... **13. C. brownii**

6* Lamina 3- or 4-pinnate at the base; pinnules lanceolate to elliptic and obtuse ..... **1. C. sieberi**

4* Lamina glabrous to densely hairy; with or without marginal fringe of hairs

7 Pinnules membranous; veins conspicuous; glabrous to densely hairy; margin not usually inrolled; 1- to 3- pinnate at the base ..... **10. C. pumilio**

7* Pinnules usually leathery; veins not usually conspicuous; glabrous or hairy; margin inrolled in some species; lamina 2- to 4-pinnate at the base

8 Lamina deltoid and 2-pinnate or 3-pinnatifid at the base; midribs on abaxial side dark for part of their length ..... **9. C. praetermissa**

8* Lamina linear to deltoid, but if deltoid then 3- or 4-pinnate at the base; midribs on abaxial side not dark for part of their length

9 Upper pinnule surface and margin completely glabrous; lower pinnule surface glabrous or hairy; pinnules at extremities of lamina not caudate

10 Lamina linear or ovate; either glabrous or with more hairs than scales at stipe–rhachis–rhachilla junctions ..... **1. C. sieberi**

10* Lamina ovate or deltoid; scales predominant at stipe–rhachis–rhachilla junctions

11 Lamina 2- to 3-pinnate at the base; pinnules rhomboid, broadly falcate or flabellate; margin strongly inrolled ..... **2. C. adiantoides**

11* Lamina 3- or 4-pinnate at the base; pinnules ovate; margin inrolled slightly ..... **3. C. austrotenuifolia**

9* Upper pinnule surface and/or margin with minute to long, very sparse to moderately dense hairs; lower surface with sparse to dense hairs; pinnules at extremities of lamina sometimes caudate

12 Lamina 3- or 4-pinnate at the base and deltoid; sparse to moderately dense long straight stiff pointed hairs on all surfaces including margin ..... **6. C. fragillima**

12* Lamina 2- to 4-pinnate at the base and linear to deltoid; hairs not as above

13 Lamina 3- or 4-pinnate at the base; ovate or deltoid; short hairs (<0.5 mm) on upper pinnule surface; longer hairs on lower pinnule surface

14 Pinnules obovate and obtuse, crowded on pinnae; sparse to moderately dense hairs on upper pinnule surface and rhachis; sparse hairs on lower pinnule surface, especially along midrib; marginal hairs sometimes present .... **5. C. contigua**

14* Pinnules ovate and acute, well spaced on pinnae; very sparse or sparse hairs on pinnule surfaces and rhachis; no marginal hairs ..... **4. C. tenuifolia**

13* Lamina 2- or rarely 3-pinnate at the base and linear or ovate; surface and/or margin of upper pinnules with short to medium length hairs (usually 0.5–1 mm); longer hairs on lower pinnule surface

15 Pinnae at base of lamina markedly basiscopically developed; moderately dense to very dense hairs on lower pinnule surface; conspicuous marginal fringe ..... **11. C. prenticei**

15* Pinnae at base of lamina not markedly basiscopically developed; sparse to moderately dense hairs on lower pinnule surface and margin ..... **12. C. hirsuta**

1. Cheilanthes sieberi *Kunze* in Lehmann, Pl. Preiss. 2: 112 (1847)

LECTOTYPE (Quirk et al. 1983: 517, Figure 10 ii, iv): WESTERN AUSTRALIA: Swan River, *Preiss 1304* (BM). ISOLECTOTYPE: P.

Cheilanthes tenuifolia subsp. *sieberi* (Kunze) Domin, Biblioth. Bot. 85: 140 (1915). LECTOTYPE: as for *C. sieberi*.

Cheilanthes tenuifolia subsp. *tenuifolia* f. *gracilior* Domin, Biblioth. Bot. 85: 138 (1915). LECTOTYPE (here chosen): SOUTH AUSTRALIA: Mt Lyndhurst, *Max Koch*, Aug 1928 (PERTH).

[*Cheilanthes sieberi* Kunze, Ind. Sem. Hort. Lips.: [1] (1839), nom. nud.]

Fronds to 35 cm long and 3.5 cm wide. *Stipe* dark brown or red-brown, glabrous or with sparse to moderately dense hairs and scales. *Rhachis* colour as for stipe, glabrous or with sparse to moderately dense hairs (to 10 cells long) and scales, hairs often twisted and glandular, densest at stipe–rhachis–rhachilla junctions. *Lamina* linear-lanceolate or ovate, tripinnate at the base, bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, lanceolate, ovate or elliptic, margins deeply incised and inrolled, upper and lower surfaces glabrous or with twisted hairs. *Spores* spherical, ornamented with varying amounts of globular, branched or reticulate deposits, verrucate beneath ornamentation, either black, ridged, 49–73 µm diam., 16 per sporangium (Figure 5a,b,e), or brown, trilete, 36–52 µm diam., 32 per sporangium (Figure 5c,d).

DISTRIBUTION AND HABITAT: Occurs throughout Australia, in all States and Territories but apparently absent from the extreme north; also recorded in New Zealand and New Caledonia. Found in both arid and non-arid areas. Recognised as poisoning stock especially at regrowth after drought. There are two subspecies.

Unlike Green (1988) and Quirk et al. (1983), we do not believe *Pteris humilis* and *Cheilanthes sieberi* to be the same species; the hair and spore characteristics of Forster's type material of *P. humilis* are typical of *C. tenuifolia* (q.v.) and not *C. sieberi*.

1 Upper pinnule surface glabrous; lower pinnule surface glabrous or almost so ..... **a.** subsp. **sieberi**

1* Upper and lower pinnule surfaces with an indumentum of twisted hairs ..... **b.** subsp. **pseudovellea**

a. Cheilanthes sieberi subsp. **sieberi**

ILLUSTRATIONS: Quirk and Chambers (1978: Figures 6a–f [as *C. sieberi*]); Quirk et al. (1983: Figures 10 [types], 11, 36); Andrews (1990: Figure 34.5A).

Rhachis and *rhachillas* glabrous or with sparse to moderately dense hairs and scales. *Pinnules* with glabrous upper surface, lower surface glabrous or with very sparse hairs (Figures 1a; 13f–h). *Spores* large or small, 16 or 32 per sporangium respectively (Figure 5a–d). $2n = 84$ (Quirk et al. 1983: 519).

DISTRIBUTION AND HABITAT: Occurs throughout Australia except for coastal areas of northern Australia (between the Kimberley region of Western Australia and the Cairns region of Queensland) and southern Australia (Great Australian Bight between Cape Arid National Park, Western Australia, and Ceduna, South Australia). Occurs on Lord Howe Island (Figure 11a). Found in arid and non-arid areas, growing in exposed rocky habitats in rock crevices or in the shelter of rocks and sometimes in open woodlands. Also occurs in New Zealand and New Caledonia.

NOTES: Some specimens from central Australia have very sparse scales at the stipe–rhachis–rhachilla junctions; these specimens are easily distinguished from *C. austrotenuifolia* by their large black verrucate spores (Figure 5; Quirk et al. 1983: Figure 36) and so far as we are aware *C. austrotenuifolia* does not occur in this region. The *C. sieberi* subsp. *sieberi* specimens that have small brown trilete spores (32 per sporangium) (Figure 5c,d) rather than the more usual large black spores (16 per sporangium) (Figure 5a,b) are not confined to any particular part of the geographic distribution of the subspecies (Figure 11a). Most 32-spored specimens of *C. sieberi* subsp. *sieberi* fit into the range of the 16-spored specimens on the scatter diagrams (Figure 9a), further supporting the interpretation that they belong to the same taxon. Although Quirk et al. (1983: 519) recognised that there were two different spore size ranges for this taxon, they did not state explicitly that each was associated with a different spore number.

SELECTED SPECIMENS: WESTERN AUSTRALIA: near Roe Dam, 30 km N of Narembeen, *R.J. Chinnock 4118*, Sep 1977 (NSW, AD). NORTHERN TERRITORY: Todd River, 9 km N of Alice Springs, *G. Chippendale*, Nov 1954 (DNA, NSW, PERTH); George Gill Range, Kings Canyon, *A.C. Beauglehole 20266*, Oct 1966 (NSW); George Gill Range, Kings Canyon, *A.F. Davies & D. Errey ACB 20385*, Oct 1966 (NSW); Reedy Creek, George Gill Range, *G. Chippendale 3643*, Aug 1957 (NSW); Mt Olga, *D. Symon 76*, June 1953 (NSW). SOUTH AUSTRALIA: Gammon Ranges, Arcoona Bluff Ra. N of Arcoona Pound, *Hj. Eichler 12610*, Sep 1956 (AD, NSW). QUEENSLAND: Walshs Pyramid, *S.T. Blake 21757*, May 1962 (BRI, NSW). NEW SOUTH WALES: Grove Creek, Abercrombie area, *E.F. Constable*, Mar 1955 (NSW); Narrabri, *J.L. Boorman*, June 1907 (NSW). VICTORIA: Deddick River, *F. Robbins*, c. 1937 (NSW); 'Malinns', 52 km N of Orbost on the Bonang Highway, East Gippsland, *K.R. Theile 859*, Jan 1985 (MELU). TASMANIA: near Antill Ponds, *M. Hood 7*, July 1951 (HO).

b. Cheilanthes sieberi subsp. **pseudovellea** *H. Quirk & T.C. Chambers*, Austral. J. Bot. 31: 522 (1983).

HOLOTYPE (Quirk et al. 1983: Figure 13): QUEENSLAND: 20 km N of Mt Isa Waterhole, *T. Farrell*, Feb 1977 (MEL 829830).

SYNONYMY: *Cheilanthes pseudovellea* (H. Quirk & T.C. Chambers) D.L. Jones, Austrobaileya 2: 469–480 (1988). HOLOTYPE: as for *C. sieberi* subsp. *pseudovellea*.

ILLUSTRATIONS: Quirk et al. (1983: Figures 12, 13 [holotype], 37 [spore of holotype]); Andrews (1990: Figure 34.5B, C).

Rhachis and *rhachillas* with moderately dense to dense twisted hairs. *Pinnules* with sparse to dense twisted hairs on both surfaces, often denser on lower surface (Figures 1b; 13i,j). *Spores* large, 16 per sporangium (Figure 5e). $2n = 82 \pm 3$ (Quirk et al. 1983: 522).

DISTRIBUTION AND HABITAT: Occurs in central Australia, from eastern Western Australia to South Australia, central New South Wales and Queensland (Figure 11b). Found in soil pockets in rocky areas of arid mountain ranges.

NOTES: *Cheilanthes sieberi* subsp. *pseudovellea* has a limited distribution, in central Australia, within the range of subsp. *sieberi*, and there is evidence that the two sometimes grow together. *Cheilanthes sieberi* subsp. *pseudovellea* differs from subsp. *sieberi* in its hair cover. Although the two subspecies are arbitrarily separated on the basis of presence or absence of hairs on the upper pinnule surface, a few specimens grade into one another. Somewhat intermediate specimens include *DNA 49288*, *DNA 42375* and *NSW 192535* (here assigned to subsp. *pseudovellea*) and *NSW 192373* and *NSW 192374* (here assigned to subsp. *sieberi*). These intermediate specimens may be hybrids between the two subspecies, although we have no definite evidence to confirm this. Given that the two have similar morphology and spore characteristics, we

do not accept Jones' (1988) raising of subsp. *pseudovellea* to specific rank. Our interpretation of the scatter diagrams support this view (Figure 9a): the two subspecies are very similar in morphological characters (for example, frond division and stipe and rhachis hair density) other than pinnule hair characters; the areas on the scatter diagrams for pinnule hair characters form a continuum within the species. While the two subspecies are readily recognised on hair characters (other than the few intermediates reported here for the first time), an examination of Figure 1a,b and Figures 10–13 in Quirk et al. (1983) will indicate how similar the two subspecies are other than in pubescence.

Cheilanthes sieberi subsp. *pseudovellea* was named because of its cover of hairs, which led previous workers to mistakenly identify it as *C. vellea*, now known as *C. brownii*. In general *C. sieberi* subsp. *pseudovellea* is easily distinguished from *C. brownii* by frond shape and by the nature (hairs twisted and often glandular in subsp. *pseudovellea*) and density of hair cover. Some specimens of *C. brownii* (for example, *DNA 82176*, *DNA 81828*, *DNA 58046*), however, have proved difficult to separate because of similarity in spore size and ornamentation to spores of *C. sieberi* subsp. *pseudovellea* (Quirk et al. 1983: Figure 37). Such specimens may be hybrids (although we have no evidence to confirm this) as the two species are usually quite distinct.

Unlike *C. sieberi* subsp. *sieberi* and *C. brownii*, no specimens of *C. sieberi* subsp. *pseudovellea* have been found with sporangia containing 32 trilete spores. In this study we have only found large spores (53–73 µm diam.) (Figure 5e) and the diameter of 32 µm given by Quirk et al. (1983: 522) seems incorrect although the size of the spore in Figure 37 of their paper is accurate.

Selected Specimens: Western Australia: Winjana Gorge, Lennard River, Napier Range, Kimberleys, *A.C. Beauglehole 11220*, Aug 1965 (NSW). Northern Territory: Macdonnell Ranges 36 km NW of Alice Springs, *D.J. Nelson 1745*, Aug 1968 (DNA, NSW); Heavitree Gap, *R. Coveny 544*, Aug 1968 (NSW); Aileron Rocks, Central Australia, (grown in glasshouse), *D. Gaff*, Aug 1971 (MEL); Valley of the Winds, Mt Olga, SW of Alice Springs, *R. Coveny 567*, Aug 1968 (NSW). South Australia: North-western end of Musgrave Ranges c. 25 km WSW of Amata, *W.R. Barker 3498*, Sep 1978 (AD). Queensland: 3.5 km W of Duchess, *C.H. Gittins*, May 1963 (NSW). New South Wales: Mount Forster, 50 miles [90 km] NW of Warren, *E.F. Constable*, May 1952 (NSW).

2. Cheilanthes adiantoides *T.C. Chambers & P.A. Farrant* **sp. nov.**

Frondes 5–15(–25) cm longae ovatae vel oblongo-ovatae ad 9 cm latae tripinnatae per 1–2 inferiora paria pinnarum gradatim bipinnatae sursum pinnatae. Pinnulae glabrae. Pinnulae fertiles rhombicae vel lanceolatae vel ovatae; margines crenati introflexique. Pinnulae steriles flabellatae vel deltatae. Sporae 32 per sporangium.

Holotype: Western Australia: 29.4 km SE of Mullewa, 28°42'S, 115°40'E, *R.J. Chinnock 5274*, 21 Oct 1981 (NSW). Isotype: AD.

Rhizome horizontal, at least to 4 cm long and c. 2.5 mm diam., putting forth many densely tufted fronds and thickly clothed with scales that are lanceolate, entire, c. 2 mm long, 0.1 mm broad, light brown, sometimes with dark brown centres. *Fronds* dimorphous; fertile fronds 5–15(–25) cm long, erect, to 9 cm wide; sterile fronds shorter, to 10 cm long, spreading, to 5 cm wide. *Stipe* red-brown to brown, 0.5–1.00 mm wide and ⅓ –2 times the length of the lamina, shiny, terete, grooved, glabrous or with very sparse 10–12-celled hairs and very sparse slender scales c. 2 mm long that are densest at the junction with the rhachis. *Rhachis* colour as for stipe, with sparse hairs (to 10 cells long) and long scales that are densest at the junctions with rhachillas. *Lamina* ovate or oblong-ovate, tripinnate or bipinnate for lower 1–2 pinnae, bipinnate to pinnate above. *Larger pinnae* 3–6-pairs, opposite, subopposite or alternate, elliptic,

ovate or oblong-ovate, petiolulate, lowermost 1.5–4.5 cm long, basiscopic halves slightly more developed than acroscopic. *Pinnules* sessile or shortly petiolate, 1–9 mm long, 1–6 mm wide, obtuse to somewhat acute, flabellate or deltoid on sterile fronds, rhomboid, ovate or lanceolate on fertile fronds if flat, or blunt and broadly falcate if folded in half laterally, margins of fertile pinnules crenate and conspicuously inrolled, often almost meeting mid-pinnule, margins of sterile pinnules entire or lobed, upper and lower surfaces glabrous, nervillae conspicuous especially at pinnule margins, usually forked. *Sori* continuous along the pinnule margin, black at maturity, entirely covered by the inrolled pinnule margin (Figures 1c; 15f–h). *Sporangia* very short-stalked, spherical, c. 0.1–0.2 mm in diameter. *Spores* black-brown, rounded-tetrahedral, varying amounts of globular and cristate ornamentation, coarsely verrucate and trilete beneath ornamentation, 41–54 µm diam., 32 per sporangium (Figure 5f,g).

Distribution and habitat: Occurs in south-western Western Australia (Figure 11c). Found around granite outcrops, on damp banks and around the bases of trees in soils over granite. A winter grower, which dries off by early spring and is possibly overlooked by collectors.

Notes: This new species was discovered by Dr R.J. Chinnock after the publication of Quirk et al. (1983). *Cheilanthes adiantoides* is so named because the flabellate shape of its sterile pinnules is reminiscent of the genus *Adiantum*: indeed, sterile specimens could be easily confused with this genus. The species is most easily confused with *C. austrotenuifolia*, which also has scales at stipe–rhachis–rhachilla junctions. It may also be confused with *C. sieberi* subsp. *sieberi* (both have verrucate spores, see Figures 5a,f,g). *Cheilanthes adiantoides* is nonetheless a distinct species, easily recognised by its very inrolled pinnule margins (and hence rhomboid–shaped pinnules), conspicuous nervillae and distinctive spore morphology. The scatter diagrams (Figure 9b) show that *C. adiantoides* is distinguishable from *C. austrotenuifolia* also on the basis of frond division and pinnule hair characters; in frond division *C. adiantoides* appears more similar to *C. sieberi* subsp. *sieberi* (Figure 9a,b).

Selected Specimens: Western Australia: c. 40 miles [64 km] W of Bullfinch, *M.E. Phillips*, Sep 1962 (NSW); 12.6 km S of Merredin on the Bruce Rock road, *R.J. Chinnock P1095*, Sep 1976 (NSW, AD); Howatharra Range, 7.5 km N of Nanson, *M.D. Tindale 2709, 2754*, Aug 1973 (NSW); Swan River 2–4 miles [3–6 km] above Northam, *H. Salasoo 337*, Oct 1949 (NSW).

3. Cheilanthes austrotenuifolia *H. Quirk & T.C. Chambers*, Austral. J. Bot. 31: 510 (1983).

Holotype (Quirk et al. 1983: Figures 4 & 5): Victoria: You Yangs Forest Park, *H. Quirk 79*, Apr 1975 (MEL 515001).

Illustrations: Quirk & Chambers (1978: Figures 3a, 4a–d); Quirk et al. (1983: Figures 4, 5, 33 [all illustrating holotype]).

Fronds to 55 cm long and 20 cm wide. *Stipe* red-brown to brown, glabrous or with sparse slender hairs (to 10 cells long) and sparse slender scales densest at the junction with the rhachis. *Rhachis* colour as for stipe, sparse hairs (to 10 cells long) and sparse to moderately dense scales, densest at the junctions with rhachillas. *Lamina* deltoid, elliptic, ovate or lanceolate, quadripinnatifid or tripinnate at base, tripinnate or bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse or somewhat acute, elliptic or ovate, margins crenate and inrolled, upper surface glabrous, lower surface glabrous or with sparse scales and hairs densest along midrib (Figures 1d, 13a–e). *Spores* spherical, with cristate ornamentation, granulose and trilete beneath ornamentation, 33–50 µm diam., 32 per sporangium (Figure 6a,b). $2n = 54 \pm 2$, 58 ± 3, 59 ± 1, 55 ± 5 (Quirk et al. 1983: 510).

Figure 13. a–e, *C. austrotenuifolia*: a habit, scale bar = 4 cm; **b** early season frond, scale bar = 4 cm; **c** fertile pinna, upper (adaxial) surface, scale bar = 1 cm; **d** fertile pinnule, lower (abaxial) surface, scale bar = 1 mm; **e** rhizome scale, scale bar = 1 mm (a,c,d,e: *Thiele 858*, MELU; b: *Beauglehole 66203*). **f–h, *C. sieberi* subsp. *sieberi*: f** fertile frond, scale bar = 4 cm; **g** fertile pinna, upper (adaxial) surface, scale bar = 1 cm; **h** fertile pinnule, lower (abaxial) surface, scale bar = 0.5 mm (*Theile 859*, MELU). **i,j, *C. sieberi* subsp. *pseudovellea*: i** fertile pinna, upper (adaxial) surface, scale bar = 5 mm; **j** hairs from pinna, scale bar = 0.5 mm (*Gaff*, MEL 516330).

DISTRIBUTION AND HABITAT: Occurs in southern Australia: Tasmania, Victoria, south-eastern New South Wales, southern South Australia and south-western Western Australia (Figure 11d). Found in areas of moderate but irregular rainfall, in rocky ground in open forest areas or on exposed sparsely wooded rocky slopes. Aerial portions of plants usually die off in the hot summer months and regrow in autumn.

NOTES: *Cheilanthes austrotenuifolia* was so named because of its resemblance to the northern *C. tenuifolia*. The two species have disjunct geographical distributions. They were separated by Quirk et al. (1983) largely on the basis of the very different spore morphologies (Quirk et al. 1983: Figures 32, 33), though other morphological differences are now shown to be of equal importance. *Cheilanthes austrotenuifolia* lacks the short hairs on the upper pinnule surface characteristic of *C. tenuifolia* and has scales at some or all of the stipe–rhachis–rhachilla junctions. This last character distinguishes *C. austrotenuifolia* from *C. sieberi* subsp. *sieberi* in areas where their distributions overlap; these two are morphologically more similar than *C. austrotenuifolia* and *C. tenuifolia*. Occasionally plants of *C. sieberi* subsp. *sieberi* from central Australia have some scales at the junctions, but these specimens are easily identified as *C. sieberi* subsp. *sieberi* by their large black verrucate spores (Figure 5a; Quirk et al. 1983: Figure 36), and *C. austrotenuifolia* does not occur in this area.

The name *Cheilanthes preissiana* Kunze in Lehm., Pl. Preiss. 2: 112 (1846), although cited by Christensen (1906) as a synonym of *C. sieberi* Kunze, may refer to *C. austrotenuifolia*. We have been unable to locate the type specimen [*Preiss 1308*: York (Swan River, Western Australia), ix. 1839] despite contacting all the herbaria that are known to house Preiss, Lehmann and Kunze material. The type may have been destroyed at Leipzig. We have examined Herbarium Henschelianum material in WRSL (no number or other collecting details) labelled, we believe by Kunze, as *C. preissiana* and photos of material in HBG (n.31, cult. Botanic Gardens Leipzig 1839), similarly determined as *C. preissiana*. The WRSL material is *C. austrotenuifolia*. The HBG material is a mixed collection of *C. austrotenuifolia* and *C. sieberi* subsp. *sieberi*. These specimens could perhaps be considered as potential neotype material; however, the mixture of species on one of the sheets is confusing and, without the necessary Preiss collecting number, we are taking the conservative view and maintaining *austrotenuifolia* as the name of the species. We have also examined *Preiss 1305* specimens (variously labelled) from BM, G and B, all of which have the characters of *C. austrotenuifolia*.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Devils Slide, Porongurup Range, *B.G. Briggs 543* (NSW); Kelmscott, *R. Helms*, Sep 1898 (NSW). SOUTH AUSTRALIA: Northern Eyre Peninsula, Cunyarie Hills c. 20 km N of Kimba, *P.G. Wilson 1870*, Sep 1960 (NSW, AD). NEW SOUTH WALES: Green Cape, lighthouse road, *E.F. Constable*, Oct 1954 (NSW). VICTORIA: Beechworth, *A. Meebold 21686*, Nov 1936 (NSW); 44 km N of Orbost on the Bonang Highway, East Gippsland, *K.R. Thiele 858*, Jan 1985 (MELU); Mitre Rock, 10 km W of Natimuk P.O., *A.C. Beauglehole 66203*, Nov 1979 (MEL). TASMANIA: North Bruny Island, *F.A. Rodway*, Jan 1901 (NSW).

4. Cheilanthes tenuifolia *(Burman f.) Swartz*, Syn. Fil.: 129, 332 (1806).

BASIONYM: *Trichomanes tenuifolia* Burman f., Fl. Indica: 237 (1768).

HOLOTYPE: CEYLON: Planta Zeylanica collection, *Burman* (G 1416, 2 sheets).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *tenuifolia*: Domin, Biblioth. Bot. 85: 137 (1915).

Pteris humilis Forster f., Prodr. Fl. Insul. Austral.: 79 (1786). *Cheilanthes humilis* (Forst. f.) P.S. Green, Kew Bull. 43: 653 (1988). LECTOTYPE (Green 1988): [collecting locality and date not indicated in Forster (1786) or on specimens] *G. Forster 261* (GOET). ISOLECTOTYPE: BM.

Cheilanthes sciadioides Domin, Biblioth. Bot. 85: 135 (1915). HOLOTYPE: QUEENSLAND: Picnic Creek, Russel [Russell] R., *K. Domin 295*, 1910 (PR).

Cheilanthes tenuifolia subsp. *queenslandica* Domin, Biblioth. Bot. 85: 140 (1915). HOLOTYPE: QUEENSLAND: Cape False [False Cape] near Yarraba [Yarrabah], *K. Domin 307*, 1910 (PR).

Cheilanthes tenuifolia subsp. *shirleyana* Domin, Biblioth. Bot. 85: 145 (1915). *Cheilanthes shirleyana* (Domin) H. Quirk & T.C. Chambers, Austral. J. Bot. 31: 510–513 (1983). HOLOTYPE: QUEENSLAND: Chilligaoe [Chillagoe], *K. Domin 306*, 1910 (PR).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 3b, 5c–f); Quirk et al. (1983: Figures 1–3, 32; Figures 6, 7, 34 [as *C. shirleyana*]); Andrews (1990: Figure 34.3A–C [A and B as *C. tenuifolia* subsp. *tenuifolia*, C as *C. tenuifolia* subsp. *shirleyana*]).

Fronds to 63 cm long and 17 cm wide. *Stipe* dark red-brown, glabrous or with sparse hairs (2–6 cells long) and very sparse slender scales. *Rhachis* colour as for stipe, with sparse hairs (2–13 cells long) and very sparse slender scales. *Lamina* pentagonal, deltoid or ovate, quadripinnate or tripinnate at base, tripinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse or acute, lanceolate or ovate, margins entire or lobed, final pinnules sometimes slightly caudate, upper and lower surfaces with very sparse short acute hairs (2–3 cells long) or occasionally almost glabrous (Figures 2a; 14c–e). *Spores* tetrahedral or rounded-tetrahedral, with varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 38–53 µm diam., 32 per sporangium (Figure 6c,d). $n = 56$ (specimen from Ceylon, Manton & Sledge 1954).

DISTRIBUTION AND HABITAT: Occurs in coastal regions of Queensland and Northern Territory (Figure 11e). Found on grassy or rocky ground in open forest areas up to 900 m altitude. Also occurs in Nepal, India, Sri Lanka, South-East Asia and the Pacific islands.

NOTES: The earliest name given to the species is *Dryopteris campestris* by Rumphius (1750: 77, t. 34, f. 2), but as this name is pre-Linnaean, it is not included in the species' synonymy. Burman later named the species *Trichomanes tenuifolia*, which was taken by Swartz (1806) as the basionym of *Cheilanthes tenuifolia*.

Domin (1915: 136–146) divided *C. tenuifolia* into a number of new subspecies; his specimens were examined in this study. Domin's specimens of his subspecies *queenslandica* (*Domin 307*) and *shirleyana* (*Domin 306*) were found to match Figure 27a and 27b respectively in Domin (1915). *Cheilanthes shirleyana* is here included under *C. tenuifolia*. Although Domin's type and the BRI specimen cited by Quirk et al. (1983: Figures 6 and 7), both examined in this study, are almost glabrous and are broader than most *C. tenuifolia* plants, the spores (Quirk et al. 1983: Figure 34) are not as distinct as believed by Quirk et al. (1983), who examined a narrower range of material. We therefore do not believe that these two specimens are sufficiently distinctive to warrant their recognition as a different taxon.

Both *Cheilanthes tenuifolia* and *C. contigua* have sparse short acute hairs on the upper pinnule surface, but the hairs on the rhachises, rhachillas and midribs of the lower pinnule surface of *C. tenuifolia* (Figure 2a; Quirk et al. 1983: Figures 2 and 3) are sparse whereas those of *C. contigua* are moderately dense (Figure 2b; Quirk et al. 1983: Figure 9). Some specimens are difficult to place as they have some characteristics of both *C. tenuifolia* and *C. contigua*. These specimens may well be hybrids, although we have no evidence (such as aborted spores) to confirm this. As well as some individual specimens being difficult to place, others occur in collections containing material of both species, and this further supports the likelihood of hybridi-

sation between the two species. Apart from the specimens that appear to be 'intermediate,' i.e. that fall into an overlapping area on the scatter diagrams (Figure 9c), most specimens fall into two non-overlapping areas, *C. tenuifolia* specimens in one and *C. contigua* in the other. The two species are usually quite distinctive, not only with respect to the hair characters shown on the scatter diagrams, but also in a large number of other characters. The two species can usually be separated on pinnule shape, the pinnules of *C. tenuifolia* tending to be ovate and acute and those of *C. contigua* obovate and obtuse. The pinnae of *C. tenuifolia* are not usually as well separated along the rhachis nor are the pinnules as crowded as they usually are in *C. contigua* (see Figures 1 and 8 in Quirk et al. 1983).

Rarely specimens of *Cheilanthes tenuifolia* have somewhat caudate pinnule tips (see Figure 7 in Quirk et al. 1983 [as *C. shirleyana*]), but these are not as strikingly caudate as *C. caudata* (see Figure 29 in Quirk et al. 1983), nor are the pinnules glabrous.

Selected Specimens: Northern Territory: Giddy River Crossing, *P.K. Latz 2902*, June 1972 (DNA, NSW); Alligator Yards c. 20 km SW of Bauhinia Downs Station, *G.J. Leach 570*, May 1985 (DNA); Walker Creek, Channel Point Road, *D.L. Jones 1756*, Dec 1984 (BRI, CANB, DNA, MEL, NSW); South Bay, Bickerton Island, Gulf of Carpentaria, *R.L. Specht 506*, June 1948 (NSW). Queensland: 6 miles [10 km] S of Caboolture, *S.T. Blake 21717*, May 1962 (BRI, NSW); Mt Lewis, *S.B. Andrews 281 & G. Stocker*, May 1975 (BRI); Yarrabah, Mission Bay, *P.R. Messmer*, July 1952 (NSW); Herberton, *R.F. Waller*, 1908 (NSW); Garraway Creek, Iron Range road, *S. Jacobs 5476 & J. Clarkson*, Aug 1987 (NSW).

5. Cheilanthes contigua *Baker*, Syn. Fil.: 476 (1874).

Holotype (Quirk et al. 1983: Figure 8): Northern Territory: Port Darwin, *R. Schomburgk 35*, Oct 1869 (K).

Synonymy: *Cheilanthes tenuifolia* subsp. *contigua* (Baker) Domin, Biblioth. Bot. 85: 146 (1915). Holotype: as for *C. contigua*.

Cheilanthes rotunda Bonaparte, Notes Ptéridologiques 4: 101 (1917). Holotype: Northern Territory: Port Darwin, *Holtze 199*, 1882 (P).

Illustrations: Quirk & Chambers (1978: Figures 3c, 5a, b); Quirk et al. (1983: Figures 8 [holotype], 9, 35); Andrews (1990: Figure 34.4B).

Fronds to 55 cm long and 12 cm wide. *Stipe* dark brown, glabrous or with sparse to dense short hairs and very sparse scales. *Rhachis* colour as for stipe, with moderately dense to dense short to medium length hairs (2–5 cells long) and very sparse long hairs and scales. *Lamina* deltoid, elliptic or ovate, quadripinnate or tripinnate at base, bipinnate for most of its length. *Larger pinnae* deltoid. *Pinnules* obtuse or somewhat acute, ovate, obovate, or oblong, final pinnules sometimes slightly caudate, margins slightly crenate, upper surface with sparse to dense minute rigid or short (1–3 cells long) acute hairs, which if minute and rigid may be conspicuous as outgrowths of margins, lower surface with sparse to moderately dense hairs (2–5 cells long) densest along midrib, or with dense minute rigid hairs (Figures 2b; 14a,b). *Spores* tetrahedral or rounded-tetrahedral, with varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 33–50 µm diam., 32 per sporangium (Figure 6f).

Distribution and habitat: Occurs in coastal regions of northern Australia, from Western Australia to Queensland (Figure 11f). Found in rocky monsoonal forested areas. Recorded also in southern India, Malaysia, Macao and New Guinea.

Notes: *Cheilanthes contigua* is most easily confused with *C. tenuifolia* and several specimens are difficult to place. Their distributions overlap but *C. contigua* has a more

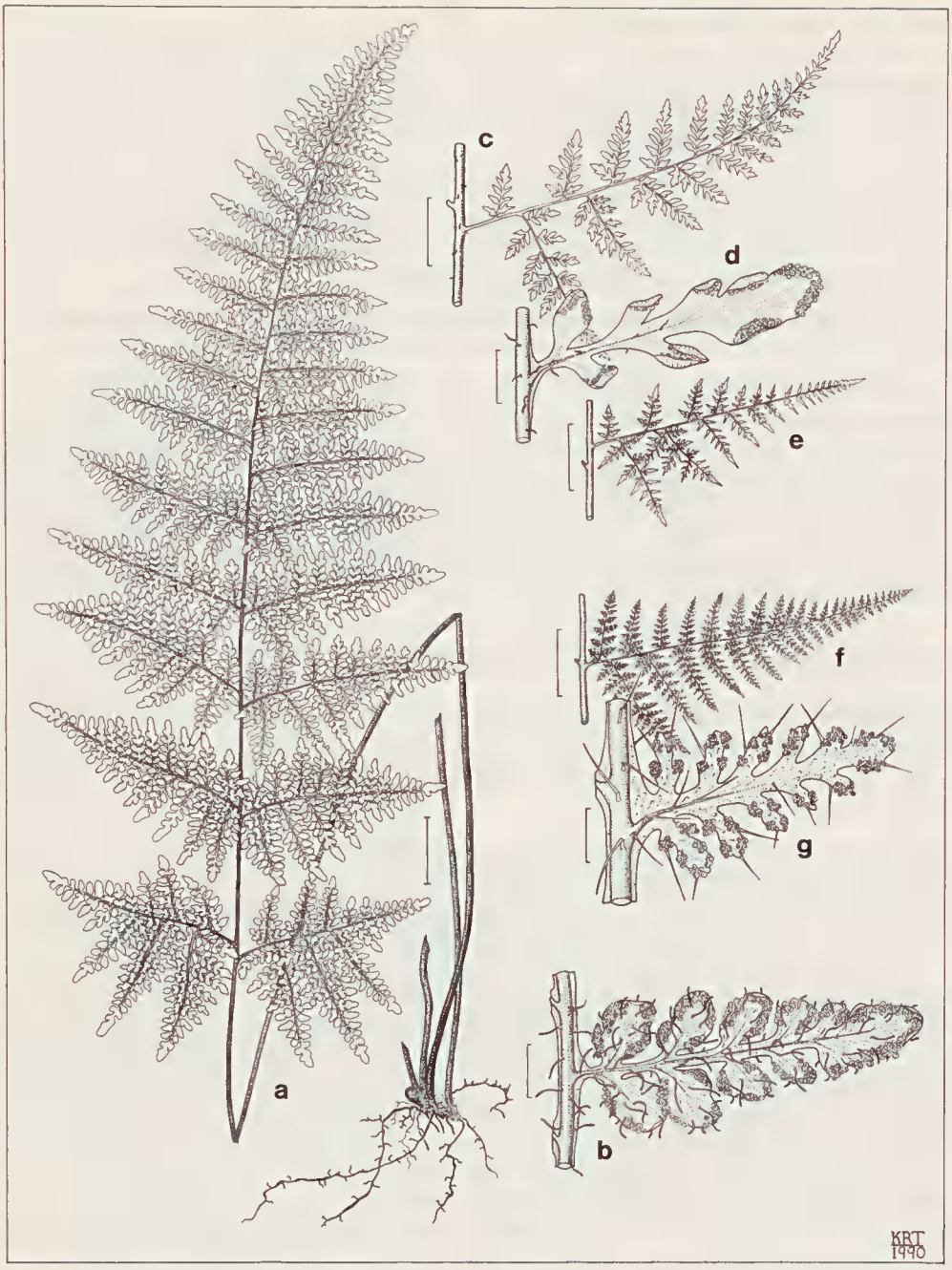

Figure 14. a,b, *C. contigua*: a habit, scale bar = 2 cm; **b** first pinnule from lowermost pinna, scale bar = 2 mm (*Jacobs 5475 & Clarkson*). **c–e, *C. tenuifolia*: c** pinna, scale bar = 2 cm; **d** first pinnule of lowermost pinna, scale bar = 2 mm; **e** pinna, scale bar = 2 cm (c,d: *Jones 1756*; e: *Blake 21717*). **f,g, *C. fragillima*: f** pinna, scale bar = 2 cm; **g** first pinnule from lowermost pinna, scale bar = 2 mm (*W. Bishop 625 & K. Bishop*).

westerly distribution into northern Western Australia. The two species have identical spore morphology (Figure 6c,d,f; Quirk et al. 1983: Figures 32, 35). *Cheilanthes contigua* differs from *C. tenuifolia* in having a denser cover of short hairs on the rhachis, rhachillas, upper pinnule surface and midribs of lower pinnule surface (Figure 9c); its pinnules are more frequently obovate and obtuse and its fronds usually have more widely separated pinnae and more crowded pinnules than those of *C. tenuifolia*.

Cheilanthes contigua is distinguished from *C. prenticei* primarily by its morphology, also by its hair cover. *Cheilanthes contigua* has finely divided fronds with short obtuse non-caudate pinnules whereas *C. prenticei* is usually bipinnate with linear-oblong or narrow deltoid pinnules, which are somewhat caudate at the frond extremities. The hairs on *C. contigua* pinnules are minute or short and usually denser on the upper than the lower surface (usually confined to the midribs of lower surface) whereas those of *C. prenticei* are longer and they are denser on the lower pinnule surface and along the pinnule margins.

Selected Specimens: Western Australia: Mt Bell in Leopold Ranges, Kimberley, *A.S. George 15145*, June 1978 (NSW, PERTH). Northern Territory: Nightcliff district, 7 km NE of Darwin, *A. Rodd*, Dec 1964 (NSW). Queensland: 3.7 km E of the Aurukun–Beagle North Camp road, *J.R. Clarkson 4525*, June 1982 (BRI, NSW); Garraway Ck, Iron Range road, *S. Jacobs 5475 & J. Clarkson*, Aug 1987 (NSW); Cape Melville Range, Bathurst Bay, *S. Jacobs 5390 & J. Clarkson*, July 1987 (NSW); Iter. Aust., *R. Brown*, 1802–1805 (NSW).

6. Cheilanthes fragillima *F. Mueller*, Fragm. 5: 123 (1866).

Replaced name: *Notholaena fragilis* Hooker, Sp. Fil. 5: 114, t. 287A (1864). Non *Cheilanthes fragilis* Hooker (1859).

Lectotype (Quirk et al. 1983: 523): Northern Territory: Fitzmaurice River, *F. Mueller*, Oct 1855 (MEL 503529).

Illustrations: Hooker (1864: t. 287A); Quirk et al. (1983: Figures 14, 15, 38, 39). Andrews (1990: Figure 34.1F).

Fronds to 32 cm long and 14 cm wide. *Stipe* dark brown, glabrous. *Rhachis* colour as for stipe, with sparse to moderately dense straight white acute hairs (1–3 cells long). *Lamina* deltoid or ovate, quadripinnate or tripinnate at base, tripinnatifid or bipinnate for most of its length. *Larger pinnae* deltoid. *Pinnules* obtuse, oblong-ovate, margins deeply lobed, upper and lower surfaces with sparse long (1–3 mm) robust straight acute white hairs (1–3 cells long) especially conspicuous along margins (Figures 2c; 14f,g). *Spores* rounded-tetrahedral, varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 41–50 µm diam., 32 per sporangium (Figure 6e).

Distribution and habitat: Occurs in coastal areas of northern Australia, from the Kimberley region of Western Australia to Arnhem Land, Northern Territory (Figure 11g). Found in rock crevices or on skeletal soils on hillsides and ridges in tropical monsoonal regions.

Notes: Although the location of Hooker's original specimen is not known, this species can be easily identified from the illustration accompanying his original description of *Notholaena fragilis* (Hooker 1864: t. 287A). This illustration also matches well with Mueller's type at MEL (listed by Quirk et al. (1983) as holotype, but actually a lectotype) and indicates that both Hooker and Mueller were referring to the same species and probably the same plant. Hooker was unsure whether the species belonged in the genus *Notholaena* or in *Cheilanthes*. In placing it in *Cheilanthes*, Mueller could not use *fragilis* as this epithet had already been applied to a different species from China.

Luerssen (1882) mistakenly applied the name *C. fragilis* to *C. fragillima* in comparing it with his new Thursday Island species, *C. prenticei*.

We include under *Cheilanthes fragillima* several Northern Territory specimens (from Melville Island, Bathurst Island and Arnhem Land) that have typical *C. fragillima*-like hairs on the rhachillas and on the midribs of the lower pinnule surface, but have short dense *C. contigua*-like hairs on the upper pinnule surface and rhachises. Morphologically they appear to be uncommon intermediates between the two species. They are probably hybrids, though we have no evidence, such as aborted spores, for this. It should be noted that both the spore size range of 22–25 µm diam. and the number of spores per sporangium (16) given by Quirk et al. (1983: 525) for *C. fragillima* are incorrect, although the spore micrograph scale gives the correct spore size (Quirk et al. 1983, Figures 38 & 39). We found that *C. fragillima* has 32 spores per sporangium and a spore size range of 41–50 µm diam. (*n*=5) (Figure 6e).

SELECTED SPECIMENS: WESTERN AUSTRALIA: N. Kimberley, Carson River Escarpment near Larryoo, *E.A. Chesterfield 449*, June 1984 (AD). NORTHERN TERRITORY: Deaf Adder Gorge, *C. Dunlop 4445*, Feb 1977 (DNA, NSW); East Alligator River near Cahills Crossing, *R. Pullen 9443*, June 1974 (DNA, NSW); creek descending escarpment Mt Brockman Outlier E. Jabiru, *W. Bishop 625 & K. Bishop*, Mar 1985 (NSW).

7. Cheilanthes caudata *R. Brown*, Prodr. Fl. Nov. Holl.: 156 (1810).

HOLOTYPE (Quirk et al. 1983: Figure 28): QUEENSLAND: Port II [Port Clinton], *R. Brown*, 1802–5 (BM).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *caudata* (R. Brown) Domin, Biblioth. Bot. 85: 144 (1915). *Cheilanthes caudata* var. *caudata* (R. Brown) S.B. Andrews, Ferns of Queensland: 330 (1990). HOLOTYPE: as for *C. caudata*.

Cheilanthes tenuifolia subsp. *caudata* var. *diversiloba* Domin, Biblioth. Bot. 85: 144 (1915). LECTOTYPE (here chosen): QUEENSLAND: Picnic Hill, Russel [Russell] R., *K. Domin 299*, 1910 (PR).

C. pinnatifida D.L. Jones, Austrobaileya 2: 472 (1988). HOLOTYPE: NORTHERN TERRITORY: Arnhem Land, Lightning Dreaming, *D.L. Jones 1478* (DNA). ISOTYPES: BRI, CANB, MEL.

ILLUSTRATIONS: Quirk et al. (1983: Figures 28 [holotype], 29, 46); Andrews (1990: Figure 34.1A [as *C. caudata* var. *caudata*]).

Fronds to 64 cm long and 16 cm wide. *Stipe* and *rhachis* red-brown to black, glabrous or with sparse hairs (1–15 cells long). *Lamina* ovate or deltoid, tripinnate or sometimes quadripinnatifid at base, bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, linear, oblong, lanceolate or rarely ovate, margins slightly crenate, final pinnules incised at base and caudate at apex, upper and lower surfaces glabrous or with sparse short or minute hairs, often along the midrib (Figures 2d; 15a,b). *Spores* with varying amounts of echinate ornamentation, either tetrahedral, trilete, 32–48 µm diam., 32 per sporangium (Figures 6g,h), or spherical, 51–60 µm diam., 16 per sporangium (Figure 6h).

DISTRIBUTION AND HABITAT: Occurs in areas inland from the northern Australian coast from the Kimberley region of Western Australia, where it is rare and large-fronded, to the Northern Territory, and the eastern coastal Cape York region of Queensland (Figure 11h). Possibly extending to New Caledonia (see *C.N. Page 4340* [BM]). Found in rock crevices or on rocky ground in open forest.

NOTES: *Cheilanthes caudata* is a distinctive species, but shows a considerable degree of variation, even on the type sheet (Quirk et al. 1983: Figure 28). Specimens at the limits of the species' morphological range may be confused with several other, possibly

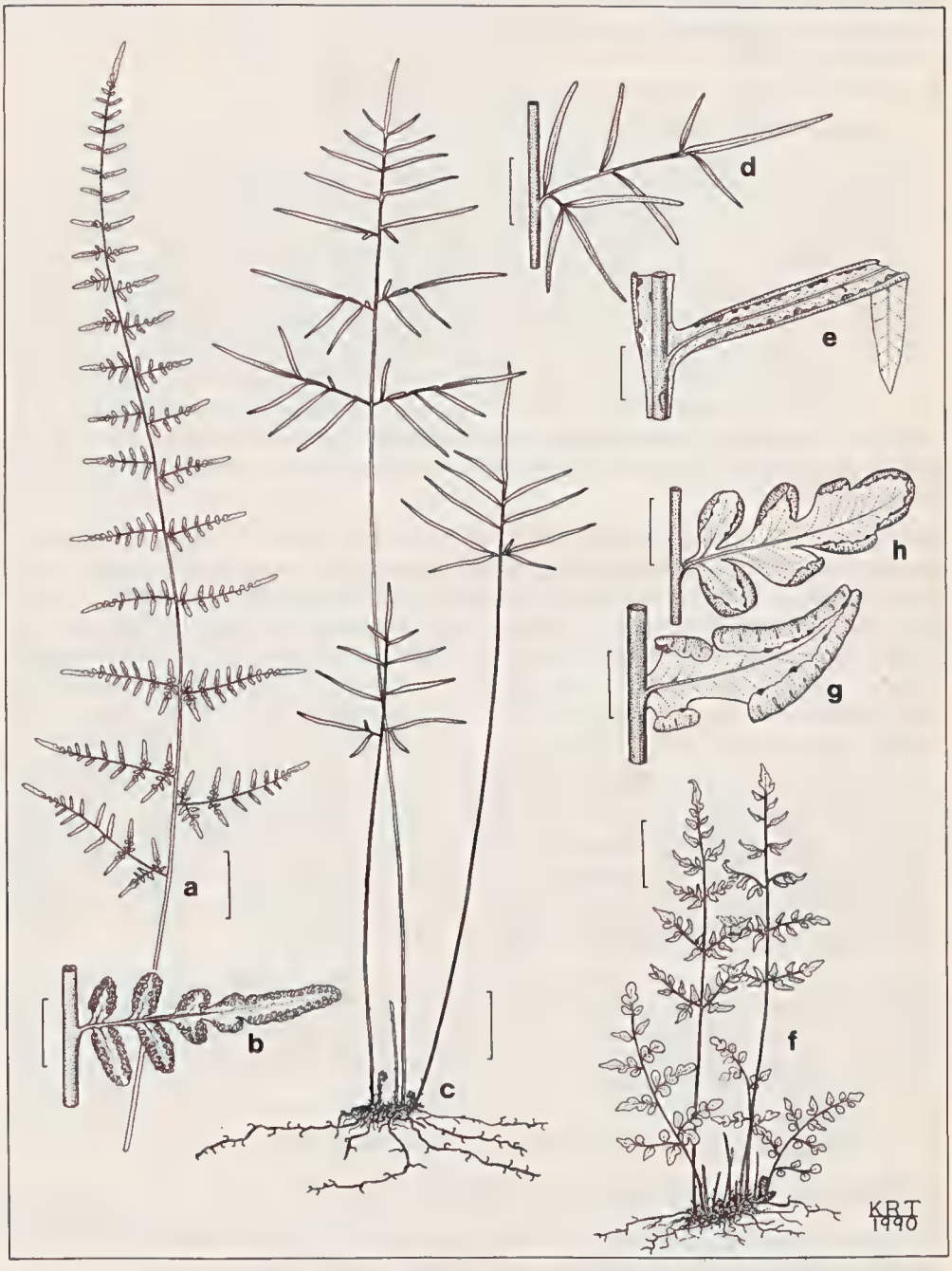

Figure 15. a,b, *C. caudata*: **a** frond, scale bar = 2 cm; **b** lowermost pinnule, scale bar = 5 mm (*Jones 1549*). **c–e, *C. nitida*:** **c** habit, scale bar = 2 cm; **d** lower pinna, scale bar = 1 cm; **e** lowermost pinnule, scale bar = 2 mm (c, e: *Jones 1407*; d: *Domin 308* (PR). **f–h, *C. adiantoides*:** **f** habit, scale bar = 2 cm; **g** lowermost pinnule, scale bar = 2 mm; **h** lowermost pinnule, scale bar = 5 mm (f,g: *Tindale 2709*; h: Salasoo 337).

related, species. *Cheilanthes caudata* is most easily confused with *C. nitida* but the two are separated on the degree of frond division and pinnule shape: *C. nitida* is bipinnate with extremely elongated, linear pinnules (see Quirk et al. 1983: Figures 30 and 31 [as *C. tenuissima*]). While possibly closely related to *C. contigua* and *C. prenticei*, *C. caudata* lacks the pubescent rhachises and pinnules of these species.

The typical *Cheilanthes caudata* is glabrous, with 32 spores per sporangium, and the final pinnules are elongated and linear with incised bases (Quirk et al. 1983: Figure 29). Under *C. caudata* we now include the single specimen referred to *Cheilanthes* sp. by Quirk et al. (1983: 547) as well as all other glabrous, caudate specimens. We also include several specimens from Queensland that have 16 spores per sporangium and very sparse hairs but are otherwise indistinguishable from the specimens with 32 spores. *Domin 299* and *310* (*Cheilanthes tenuifolia* subsp. *caudata* var. *diversiloba* Domin) are in this group. On the scatter diagrams (Figure 9d) the 16-spored specimens of *C. caudata* mostly fit into the range of the 32-spored specimens, except that they tend to have denser hairs on the pinnule surfaces; the type (32-spored) falls in the overlapping area. The 16-spored forms may be hybrids of *C. caudata* with another species, perhaps *C. hirsuta*, since the spores are sometimes echinate like those of *C. hirsuta* (Figure 8e; Quirk et al. 1983: Figure 44); cytological evidence would be needed to substantiate this.

We include *Cheilanthes pinnatifida* D.L. Jones under *C. caudata*. Comparison of over 20 vegetative and reproductive characters of the types of *C. caudata* (*R. Brown 78*) and *C. pinnatifida* (*D.L. Jones 1478*) indicates very close similarity of the two and no marked character disjunctions. A spore of the type of *C. pinnatifida* is shown in Figure 6g. The two types cannot be distinguished by stipe colour, a character Jones (1988) suggests is useful for distinguishing the species. The *C. pinnatifida* type is almost identical to the topmost frond on the *C. caudata* type sheet, from which it differs only in the degree of division (tripinnatifid rather than tripinnate). Other specimens cited by Jones (1988) for *C. pinnatifida* are tripinnate (for example, *Dunlop 5284*). We cannot therefore agree with Jones' statement that *C. pinnatifida* is more like *C. nitida* than *C. caudata* since we believe that *C. pinnatifida* and *C. caudata* are the same species. Jones (1988) suggests that *C. pinnatifida* differs from *C. nitida* in the extent of frond division and pinnule length; the same differences separate *C. caudata* from *C. nitida*. Jones (1988) also draws attention to the distinctive lobing which precedes the apical cauda on most pinnae of *C. pinnatifida*; this is also true for *C. caudata*.

Selected Specimens: Northern Territory: 3 km SE Jim Jim Falls, Arnhem Land, *D.L. Jones 1521*, Mar 1984 (AD, BRI, CANB, DNA, MEL, NSW, PERTH); headwaters of East Alligator River, *D.L. Jones 1549*, Mar 1984 (AD, NSW). Queensland: 3.3 km S of Fairview, *J.R. Clarkson 3208*, Apr 1980 (BRI); Tinaroo Creek road, at crossing of Douglas Creek, 10.5 km SE of Mareeba, *A. & R. Tryon 7344*, Aug 1983 (NSW).

8. Cheilanthes nitida *(R. Brown) P.S. Green*, Kew Bull. 43: 653 (1988).

Basionym: *Pteris nitida* R. Brown, Prodr. Fl. Nov. Holl.: 155 (1810).

Holotype: Northern Australia: Tropical Australia, *R. Brown s.n.* (not traced). Neotype (Green 1988): Northern Territory: Port Darwin, *Schultz 796* (K).

Synonymy: *Pellaea nitida* (R. Br.) Baker in Hooker & Baker, Syn. Fil.: 478 (1874). Type: as for *Pteris nitida*.

Acrostichum pteroides R. Brown, Prodr. Fl. Nov. Holl.: 145 (1810). *Neurosoria pteroides* (R. Brown) Mettenius, Bot. Zeitung (Berlin) 27: 438 (1869). Non *Cheilanthes pteroides* Swartz (1806). Holotype: Northern Australia: North Coast Island, *R. Brown 3* (BM).

Cheilanthes tenuissima Bailey, Queensl. Agric. J. 17: 28, t. 3 (1906). *Cheilanthes tenuifolia* subsp. *caudata* var. *tenuissima* (Bailey) Domin, Biblioth. Bot. 85: 144 (1915). *Cheilanthes caudata* var. *tenuissima* (Bailey) S.B. Andrews, Ferns of Queensland: 330 (1990). HOLOTYPE: QUEENSLAND: Islands of Torres Strait, *T. Tate s.n.* (BRI 18855).

ILLUSTRATIONS: Quirk et al. (1983: Figures 30 [incorrectly labelled as holotype], 31, 47 [as *C. tenuissima*]); Andrews (1990: Figure 34.1B [as *C. caudata* var. *tenuissima*]).

Fronds to 34 cm long and 12 cm wide. *Stipe* and *rhachis* dark brown to black, glabrous or with sparse or, rarely, moderately dense, hairs (2–6 cells long, sometimes longer). *Lamina* ovate or oblong, bipinnate at base (the innermost basal pinnule may be trifoliolate) and for most of its length. *Larger pinnae* deltoid. *Pinnules* somewhat acute, narrow, linear, at least ten times longer than broad, margins entire or, rarely, lobed, upper surface glabrous or, rarely, with dense minute rigid hairs (Figures 3a; 15c–e), lower surface glabrous or with short hairs on midrib. *Spores* tetrahedral, with varying amounts of echinate ornamentation, granulose and trilete beneath ornamentation, 36–47 µm diam., 32 per sporangium (Figure 7c).

DISTRIBUTION AND HABITAT: Occurs in coastal areas of northern Australia from Northern Territory to Cape York Peninsula, Queensland (Figure 12a). Found in rocky or shallow soil in open forest areas.

NOTES: Robert Brown (1810) named this species *Acrostichum pteroides*. It was then moved to become the only species of *Neurosoria*, a genus created by Mettenius in 1869. Copeland (1947) recognized its close affinity with *Cheilanthes caudata*, which has fronds that are always tripinnate below. However, we believe that the species is clearly distinguishable from *C. caudata* and that the species (*A. pteroides*) and the genus *Neurosoria* both belong in *Cheilanthes*. As Green (1988) points out, the epithet *pteroides* cannot be used for this species because of Swartz's quite different *Cheilanthes pteroides* dating from 1806.

We are accepting that *Pteris nitida* R. Br. is synonymous with (and the basionym of) *Pellaea nitida* Baker, although the question cannot be resolved finally until the missing Brown type specimen (from tropical Australia) is located. As pointed out by Green (1988), the correct name and citation for the species in the meantime should be *Cheilanthes nitida* (R. Br.) P.S. Green. Green (1988) has chosen one of the two specimens that Baker (1874) cited (which are conspecific with Bailey's) as neotype of *Pteris nitida*.

Cheilanthes nitida is very close to *C. caudata*, from which it differs mainly in the extent of frond division (Figure 9d) and the length of the pinnules; hair characters can also distinguish the two species (Figure 9d). An apparent overlap in the first scatter diagram (for frond division) occurs due to the trifoliolate nature of the innermost pinnules of the lowest pinnae of *C. nitida*. In practice such specimens are easy to distinguish from the occasional bipinnate or tripinnatifid specimen of *C. caudata*.

Although the two species are usually easy to separate, one specimen 'found growing with [the] holotype of *C. tenuissima*' by Tate in the islands of Torres Strait (*BRI 224919*) is almost intermediate in form between the two, and it may well be a hybrid. We have seen only a single specimen of *C. nitida* that is tripinnate at the base (*DNA 13392*). Some *C. nitida* plants have relatively broad pinnules and may be difficult to separate from *C. tenuifolia* and *C. praetermissa* (for example, *DNA 11562*). *Cheilanthes nitida* is usually glabrous or nearly so; we have seen one specimen with dense minute rigid hairs on the upper pinnule surface (*DNA 26665*) and one specimen with hairy stipe and rhachis (*DNA 29593*).

Selected Specimens: Northern Territory: Kapalga, *D.L. Jones 1407*, Feb 1984 (AD, BRI, CANB, DNA, MEL, NSW, PERTH). Queensland: Tozers Gap, *S. Jacobs 5473 & J. Clarkson*, Aug 1987 (NSW); Speewah Upper Clohesy R., *L.J. Brass 18244*, Mar 1948 (BRI); Gorge Creek, 10 miles [16 kms] W of Mareeba, *H.S. McKee 9271*, Apr 1972 (NSW); Yarraba [Yarrabah], *Domin 308*, 1909-1910 (PR).

9. Cheilanthes praetermissa *D.L. Jones*, Austrobaileya 2(5): 472 (1988).

Holotype: Northern Territory: Arnhem Land, near Mt Howship, East Alligator River Area, *D.L. Jones 1443*, Feb 1984 (DNA). Isotypes: BRI, CANB, MEL.

Illustrations: D. Jones (1988: Figure 2C,D [drawn from type]).

Fronds to 26 cm long and 8 cm wide. *Stipe* and *rhachis* dark red-brown, glabrous or with sparse scales and sparse hairs of varying lengths. *Lamina* deltoid, bipinnate to tripinnatifid at the base, bipinnatifid for most of its length. *Larger pinnae* deltoid. *Pinnules* obtuse or acute, linear-oblong or linear-deltoid, broader and rounded for lower pinnae or sterile fronds, final pinnules sometimes slightly caudate, margins entire or lobed, upper surface glabrous or with sparse short hairs, lower surface glabrous or with sparse short to medium length hairs densest on midribs (Figures 3b; 16c,d). *Spores* rounded-tetrahedral, with sparse reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 33–45 µm diam., 32 per sporangium (Figure 7a,b).

Distribution and habitat: Occurs in northern Northern Territory (Figure 12b). Found in rocky areas of open forest in sandy or gravelly soil.

Notes: The holotype of *Cheilanthes praetermissa* is not glabrous as described by Jones (1988); the upper pinnule surface has small multicellular acute hairs, and the lower pinnule surface has sparser small–medium length hairs, some of which have glandular tips; the rhachis and stipe have sparse hairs of various lengths.

Although Jones (1988) states that *C. praetermissa* is similar in general form to *C. nudiuscula*, we know of only three specimens of the latter and these are now placed in either *C. hirsuta* (the type of *C. nudiuscula, Brown 60*) or *C. prenticei* (BRI 226376 [2 specimens, formerly BRI 218826 and BRI 087848]).

Cheilanthes praetermissa is most easily confused with *C. pumilio* and occurs within its geographic range. The two are similar in degree of frond division and stipe and rhachis hair density, but pubescent specimens of *C. pumilio* have denser hairs on the pinnules than pubescent specimens of *C. praetermissa* (Figure 10a). The two species, especially the more easily confused glabrous specimens, can usually be separated on the basis of frond texture: *C. pumilio* fronds are membranous whereas those of *C. praetermissa* are leathery. *Cheilanthes praetermissa* has 32 spores that are similar to, but not as ornamented as, those of the 32-spored specimens of *C. pumilio* (Figure 7d–f; Quirk et al. 1983: Figure 43).

Pubescent specimens of *Cheilanthes praetermissa* may be confused with *C. contigua*. *C. praetermissa* is recognised by its coarser, leathery fronds and by the shape of its pinnules; the pinnules are elongate and usually taper evenly, whereas those of *C. pumilio* and *C. contigua* are usually shorter with more rounded ends. *Cheilanthes praetermissa* also has pinnule midribs noticeably dark for up to two-thirds of the pinnule length, immersed veins (except at the pinnule margins) and the lowest pair of pinnae very unequally basiscopically divided.

Selected Specimens: Northern Territory: Lightning Dreaming, Arnhem Land, *D.L. Jones 1490*, Feb 1984 (BRI, CANB, DNA); East Alligator River area near Mt Howship, Arnhem Land, *D.L. Jones 1435*, Feb 1984 (BRI, CANB, DNA, MEL); Twin Falls, *C. Dunlop 6674 & J. Taylor*, Mar 1982 (DNA);

near Mount Basedow, c. 16.5 miles [26 km] SSE of Nourlangie Safari Camp, *M. Lazarides 7876*, Feb 1973 (DNA, NSW); base of Koongarra Saddle, Kakadu N.P., *M. Tindale 10040 & P. Munns*, July 1989 (NSW).

10. Cheilanthes pumilio *(R. Brown) F. Mueller*, Syst. Census Austral. Pl.: 138 (1882).

Basionym: *Notholaena pumilio* R. Brown, Prodr. Fl. Nov. Holl.: 146 (1810). [*Pteris pumilio* Banks & Solander, ined.]

Holotype: Queensland: Endeavour River, *Banks & Solander*, 1770 (BM, photo seen; fragment of holotype: NSW 192292).

Synonymy: *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *pumilio* (R. Brown) Domin, Biblioth. Bot. 85: 142 (1915) excluding *Domin 316*. Holotype: as for *Notholaena pumilio*.

Cheilanthes paucijuga Baker in Hooker & Baker, Syn. Fil.: 515 (1874). Holotype: Northern Territory: Port Darwin, *Schomburgk*, Oct 1859 (K, specimen seen by K. Wilson).

Cheilanthes cavernicola D.L. Jones, Austrobaileya 2: 469 (1988). Holotype: Northern Territory: Oenpelli area, Arnhem Land, *Henshall 1951*, 12 June 1978 (DNA). Isotypes: AD, BRI.

Cheilanthes dunlopii D.L. Jones, Austrobaileya 2: 470 (1988). Holotype: Northern Territory: Keep River National Park, *Dunlop 5838*, 3 Mar 1981 (DNA).

Illustrations: Quirk et al. (1983: Figures 22, 23, 43); Andrews (1990: Figure 34.1E).

Fronds to 50 cm long and 15 cm wide. *Stipe* and *rhachis* dark brown or red-brown, glabrous or with sparse to moderately dense hairs and scales of varying lengths, some glandular. *Lamina* deltoid or ovate, pinnate, bipinnate, tripinnatifid or tripinnate at the base, bipinnatifid or pinnate for most of the length. *Larger pinnae* deltoid, ovate or lanceolate. *Pinnules* obtuse or acute, elliptic, oblong or deltoid, final pinnules sometimes slightly caudate, margins entire or lobed, not usually inrolled, upper and lower surfaces glabrous or with sparse to dense short to long slender or cottony hairs (1–7 cells long) densest at the margins or midribs (Figures 3c; 16g–i). *Spores* with echinate ornamentation, granulose beneath ornamentation, either rounded tetrahedral and trilete, 33–50 µm diam., 32 per sporangium (Figure 7d–f), or spherical, 50–68 µm diam., 16 per sporangium (Figure 7g,h).

Distribution and habitat: Occurs in far northern Australia, from Western Australia to Northern Territory and the Cape York region, Queensland (Figure 12c). Found in rocky mountainous habitats.

Notes: *Cheilanthes pumilio* is easily distinguished by the membranous texture of its fronds; veins are clearly visible and hydathodes usually present. We now extend the range of variation considerably to include plants with a wide range of lamina and pinnule shapes and hair cover, with continuous or discrete sori, and robust specimens with frond division up to the tripinnate level. Some of these robust specimens have much greater frond and spore dimensions than the ranges published by Quirk et al. (1983: 533) and they have 16 spores per sporangium. The type material of *C. pumilio* is among these 16-spored forms. The 16-spored specimens fit within the range of the 32-spored specimens on the scatter diagrams (Figure 10a). However, the 16-spored specimens of *C. pumilio* tend to be rather robust (taller with more divided fronds), with fronds that are somewhat thicker than the 32-spored specimens, though still membranous and therefore easily distinguished from *C. hirsuta*. Either the 32-spored or 16-spored forms of *C. pumilio* may be hybrids of *C. pumilio* with another species.

Quirk et al. (1983) did not report the existence of 16-spored forms of *Cheilanthes pumilio*, probably because of the smaller number of specimens available to them. The spore size of 24 µm diam. given by Quirk et al. (1983: 533) seems to be incorrect: in this study we found the size range of spores to be 33–50 µm (32-spored forms) (Figure 7d–f) and 50–68 µm (16-spored forms) (Figure 7g,h). An unpublished photograph by Quirk et al. of a spore from the type of *C. pumilio* shows that it fits into the size range of the 16-spored form, and after examination of more spores from the type in this study (Figure 7g), we can confirm the absence of trilete marks on these spores.

Under *Cheilanthes pumilio* we include *C. dunlopii* and *C. cavernicola*, two species recently described by Jones (1988). Spores from the type specimens of both are shown in Figure 7. Known only from the type specimen, *C. dunlopii* fits into our widened description of *C. pumilio*. Specimens of *C. cavernicola*, though paler and more hairy than most specimens of *C. pumilio*, fall at one end of, but within, the morphological range of the species and we believe that their morphology can probably be attributed to their habitat (moist shallow caves).

Domin's material of *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *pumilio* (*Domin 316*) has coarse hairs and leathery texture and belongs in *C. hirsuta*.

Selected Specimens: Western Australia: 'Theda' Station, Kimberley district, *I.R. Telford 6234 & G.Butler*, June 1977 (CANB, NSW, PERTH); Kings Sound, *W.W. Frogatt*, 1888 (NSW). Northern Territory: 11 km SSW Bing Bong H.S., *N.M Henry 141*, June 1971 (AD, DNA); Katherine Gorge, *M.D. Tindale 6054*, July 1979 (NSW); Katherine National Park, *A. Wood R790396a*, July 1979 (NSW); Mount Brockman Outlier, Kakadu National Park, *J. Russell-Smith 8064 & D. Lucas*, Apr 1989 (CANB, DNA, NSW); Darwin, *H.S. McKee 8267*, Jan 1961 (BRI, DNA, NSW). Queensland: 0.6 km E of Wenlock River, *R. Coveny 7081a & P. Hind*, Sep 1975 (NSW); 20 miles [32 km] NNW of Mount Isa, *C.H. Gittins*, May 1963 (NSW).

11. Cheilanthes prenticei *Luerssen*, Bot. Centralbl. 9(1): 442 (1882).

Holotype: Queensland: Thursday Island, *Prentice, Herb. Fil. Luerssen No. 10834*, 1881 (n.v., location unknown).

Lectotype (here chosen): probable fragment of holotype, labelled *'Cheilanthes prenticei* Lssn, Thursday Island, Prentice Leg.': MEL 1562952.

Illustrations: Andrews (1990: Figures 34.1C, 34.3E).

Fronds to 29 cm long and 7 cm wide. *Stipe* dark brown to black, glabrous or with sparse to dense short hairs (2–3 cells long) and very sparse long hairs and scales. *Rhachis* colour as for stipe, with moderately dense to dense short to medium length hairs (3–5 cells long, occasionally to 14 cells long). *Lamina* elliptic, ovate or lanceolate, bipinnate, occasionally tripinnate, at the base, bipinnate for most of its length. *Larger pinnae* deltoid, ovate or lanceolate, lowermost with basiscopic half more developed than acroscopic. *Pinnules* somewhat acute, linear-oblong or narrow-deltoid, final pinnules sometimes slightly caudate, margins entire or lobed, upper surface glabrous or with sparse to moderately dense medium length acute hairs (2–3 cells long) conspicuous as marginal fringe, lower surface with moderately dense to very dense longer (c. 1 mm) hairs (Figures 3d; 16e,f). *Spores* rounded-tetrahedral, usually coarsely echinate, granulose and trilete beneath ornamentation, 35–45 µm diam., 32 per sporangium (Figure 8c,d).

Distribution and habitat: Occurs only in the Cape York region of northern Queensland and Thursday Island in the Torres Strait (Figure 12d). Found in shaded sandstone areas amongst shrubs.

Notes: *Cheilanthes prenticei* is most easily confused with *C. contigua* and *C. hirsuta*. The fronds of *C. prenticei* are not as finely divided as those of *C. contigua*. *Cheilanthes*

prenticei has longer hairs than *C. contigua* and the hairs are denser on the lower pinnule surface than the upper surface and are conspicuous along the margins, which tend to turn under. *C. contigua* has sparser hairs on the lower pinnule surface (usually only on the midrib) than on the upper pinnule surface. Some specimens of *C. prenticei* are morphologically similar to *C. hirsuta*, although most specimens of *C. prenticei* can be identified by the much denser fringe of long hairs on the inrolled pinnule margins, the greater development of the basiscopic half of the lowermost pinnae and the darker colour of the rhachis.

Luerssen (1882) described *Cheilanthes prenticei* from a specimen collected by Prentice and sent to him by Mueller. This type specimen was lodged at Leipzig, and therefore may have been lost during the Second World War; we have been unable to locate it at any of the herbaria that house Luerssen's or Prentice's specimens. However, the lectotype (MEL 1562952), which we believe is probably a small fragment of the holotype, has almost glabrous upper pinnule surfaces, thus fitting Luerssen's description (1882) of *C. prenticei*. In the present study, several specimens from Thursday Island (the type locality) were examined. While a few have glabrous upper pinnule surfaces, most specimens have a sparse to moderately dense hair cover but otherwise match the fragment and protologue; hence we have widened the species description to accommodate the wider range of specimens now available.

Selected Specimens: Queensland: Browns Creek, Pascoe River, *L.J. Brass 19596*, July 1948 (BRI); Herberton, *coll. unknown*, Jan 1912 (BRI 226376 [formerly BRI 218826 and BRI 087848]); Thursday Island, *R.W. Coppinger*, date unknown (BRI 314660 [formerly BRI 218711], NSW); Thursday Island, *T. Tate*, Oct 1905 (BRI, NSW); Cape York Peninsula, *J.E. Young*, July 1923 (BRI).

12. Cheilanthes hirsuta *(Poiret) Mettenius*, Abh. Senckenb. Naturf. Ges. 3: 69 (1859).

Basionym: *Pteris hirsuta* Poiret, Encycl. 5: 719 (1804).

Holotype: unknown locality and date, *P. Sonnerat* (P-LA, photo seen).

Synonymy: *Pteris nudiuscula* R. Brown, Prodr. Fl. Nov. Holl.: 155 (1810). *Cheilanthes nudiuscula* (R. Brown) T. Moore, Ind. Fil.: 249 (1860). *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *glabrata* Domin, Biblioth. Bot. 85: 142 (1915). Holotype (Quirk et al. 1983: Figure 26): Northern Australia: Coast 'T' [Tropical: the coast of Queensland and the Northern Territory westward to Arnhem Bay], *R. Brown 60*, 1802–5 (BM).

C. tenuifolia subsp. *nudiuscula* f. *pubescens* Domin, Biblioth. Bot. 85: 142 (1915). Lectotype (here chosen): Queensland: Picnic Hill, Russel [Russell] R., *K. Domin 313* (PR).

Illustrations: Quirk et al. (1983: Figures 24, 25, 44 [as *C. hirsuta*], 26, 27, 45 [as *C. nudiuscula*; Figures 26, 45 of holotype and spore of holotype respectively]); Andrews (1990: Figure 34.3D, 34.4A; Figure 34.2A [as *C. nudiuscula*]).

Fronds to 36 cm long and 5 cm wide. *Stipe* dark red-brown, glabrous or with sparse short stiff hairs (1–4 cells long) and very sparse scales. *Rhachis* colour as for stipe, with sparse to moderately dense hairs (usually short, occasionally to 14 cells long) and sparse scales. *Lamina* elliptic or lanceolate, bipinnate to tripinnate at the base, bipinnatifid for most of its length. *Larger pinnae* deltoid-ovate, lowermost with basiscopic and acroscopic halves equally developed. *Pinnules* obtuse or acute, oblong, triangular or deltoid, margins entire or lobed, upper surface occasionally glabrous, usually with sparse slender short to medium length hairs (1–4 cells long) densest at the margins, lower surface with sparse to dense medium to long hairs (Figures 4a; 16a,b). *Spores* spherical, with varying amounts of echinate ornamentation, granulose and ridged beneath ornamentation, 40–64 µm diam., 16 per sporangium (Figure 8e).

Figure 16. a,b, ***C. hirsuta:*** **a** habit, scale bar = 2 cm; **b** first pinnule of lowermost pinna, scale bar = 3 mm (*Blaxell 519*). **c,d,** ***C. praetermissa:*** **c** fronds, scale bar = 2 cm; **d** first pinnule of lowermost pinna, scale bar = 3 mm (*Lazarides 7876*). **e,f,** ***C. prenticei*****: e** frond, scale bar = 2 cm; **f** first pinnule of lowermost pinna, scale bar = 3 mm (*Brass 19596*, BRI 4537). **g–i,** ***C. pumilio*****: g** habit, scale bar = 2 cm; **h** habit of robust specimen, scale bar = 2 cm; **i** first pinnule of lowermost pinna, scale bar = 3 mm (g: *Russell-Smith 8064 & Lucas*; h,i: *McKee 8267*).

DISTRIBUTION AND HABITAT: Occurs mainly in coastal areas of eastern Queensland, more rarely in inland areas of northern Northern Territory and the Kimberley region of Western Australia (Figure 12e). Found on steep rocky exposed hillsides or in crevices of rocks or cliffs, often near a creek or gorge. Also occurs in Hong Kong, Timor, Philippines, New Caledonia and Fiji.

NOTES: The Australian specimens match the photo of the type and the descriptions of *Cheilanthes hirsuta* by both Desvaux (1813) and Mettenius (1869). After examining a wide range of specimens and the photograph of the type, we believe *C. hirsuta* in its hair and spore characters to be an extremely variable species, and we now include *C. nudiuscula* under *C. hirsuta* (see Quirk et al. 1983: Figures 24–27). The typical *C. hirsuta* is bipinnate; however, some specimens are tripinnate or tripinnatifid. Typically *C. hirsuta* has sparse medium length hairs on the upper pinnule surface and moderately dense hairs on the lower pinnule surface and rhachis. The pinnules or pinnule lobes of *C. hirsuta* range from oblong and rounded to triangular or deltoid. *Cheilanthes hirsuta* has 16 spherical spores per sporangium and the spores are typically echinate (Figure 8e; Quirk et al. 1983: Figure 44); however, the amount of ornamentation is variable and some specimens have spores that are quite plain. The type of *Cheilanthes nudiuscula* is not of typical *C. hirsuta*, but fits into the range of variation, for both frond morphology (Quirk et al. 1983: Figure 26) and spore morphology (Quirk et al. 1983: Figure 45), as do Domin's specimens of *C. tenuifolia* subsp. *nudiuscula* f. *pubescens* (*Domin 300*, *313*, *314*, and *315*) and *C. tenuifolia* subsp. *nudiuscula* f. *glabrata* (*Domin 311*, *312*). Domin's specimen (*316*) of *C. tenuifolia* subsp. *nudiuscula* f. *pumilio* is also referable to *C. hirsuta*.

Cheilanthes hirsuta is most easily confused with *C. pumilio*, a species that is easy to recognise because of the thin membranous texture of its fronds. *Cheilanthes pumilio* usually has 32 spores per sporangium, whereas *C. hirsuta* has 16 spores per sporangium. However, some specimens of *C. pumilio*, including the type specimen, have 16 spores per sporangium. These 16-spored specimens of *C. pumilio* also sometimes have *C. hirsuta*-like hairs on the pinnules, though they are thin-textured like most collections of *C. pumilio*.

Cheilanthes hirsuta can also be confused with *C. prenticei*, a relatively rare species found only in far northern Queensland. *Cheilanthes prenticei* is recognisable by the very dense long hairs on the lower pinnule surface; the same type of hairs usually form a fringe along the pinnule margins. *C. prenticei* also has a darker rhachis and the basiscopic halves of the lowermost pinnae are more developed than the acroscopic halves. While the two species are easily separated on morphological characters, including pinnule hair distribution (Figure 10b), their different spore numbers can also be useful: *C. hirsuta* has 16 spores per sporangium, whereas *C. prenticei* has 32.

SELECTED SPECIMENS: NORTHERN TERRITORY: 7 km NE of Mountain Valley H.S., *D.J. Nelson 187*, Apr 1962 (BRI, DNA). QUEENSLAND: Mareeba, *S.T. Blake 9473*, June 1935 (BRI); Trinity Bay, *A.C. Beauglehole 3332*, June 1955 (NSW); Tinaroo Creek road at Douglas Creek crossing, *A. Tryon 7346 & R. Tryon*, Aug 1983 (NSW); Valley of Lagoons H.S., Upper Burdekin River, *D.F. Blaxell 519*, May 1971 (NSW); S of Cooktown, Annan Gorge, *S.T. Blake 23391*, May 1970 (NSW).

13. Cheilanthes brownii *(Kuhn) Domin*, Biblioth. Bot. 85: 133 (1915).

BASIONYM: *Gymnogramme brownii* Kuhn, Analecta Pteridographica 9: 458 (1869).

HOLOTYPE (Quirk et al. 1983: Figure 18): NORTHERN TERRITORY: Arnheim [Arnhem] South Bay, Point U [Mount Caledon], *R. Brown 5*, 6 Feb 1803 (BM).

SYNONYM: *Notholaena vellea* R. Brown, Prodr. Fl. Nov. Holl.: 146 (1810). Non *Cheilanthes vellea* (Aiton) F. Mueller, Fragm. 5: 123 (1866).

Figure 17. *C. brownii*: **a** habit, scale bar = 1 cm; **b** pinna upper surface, scale bar = 5 mm; **c** T.S. of fertile pinnule, scale bar = 0.5 mm; **d** hair from lower (abaxial) pinna surface, scale bar = 0.2 mm; **e** rhizome scale, scale bar = 0.5 mm (*Beauglehole 47386 & Carr 3608*).

[*Notholaena brownii* Desvaux, Prodr.: 220 (1827), nom. illeg.]

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 9a, b [as *C. vellea*]); Quirk et al. (1983: Figures 18, 19, 41 [as *C. brownii*; Figure 18 of type); Andrews (1990: Figure 34.2C).

Fronds to 35 cm long and 5 cm wide. *Stipe* and *rhachis* dark brown to black, with sparse to dense long slender acute hairs (6 to 12 cells long), and very sparse scales. *Lamina* elliptic or lanceolate, bipinnate or tripinnate at base, bipinnate for most of its length. *Larger pinnae* narrow-deltoid. *Pinnules* rounded, deltoid, margins entire or lobed, upper surface with sparse to very dense long hairs, lower surface with extremely dense long hairs (Figures 4b; 17). *Spores* spherical, ornamented with varying amounts of globular or randomly branched deposits or, sometimes, echinate processes, smooth or granulose beneath ornamentation, either ridged, 47–71 µm diam., 16 per sporangium (Figure 8h), or trilete, 34–48 µm diam., 32 per sporangium (Figure 8f,g).

DISTRIBUTION AND HABITAT: Occurs in northern, central and south-western Australia, in Western Australia, Northern Territory and Queensland (Figure 12f). Found in soil pockets or rock crevices on wooded rocky hillsides or cliffs of arid and semi-arid areas.

NOTES: *Cheilanthes brownii* is distinguished from *C. sieberi* subsp. *pseudovellea* by its denser cover of hairs, which are not branched, twisted or glandular, and differs from *C. lasiophylla* in having simple rather than branched scales and hairs.

The presence of 32-spored as well as 16-spored forms of *Cheilanthes brownii* is reported here for the first time: the 32-spored plants are morphologically indistinguishable from the 16-spored specimens and fit into the range of the 16-spored specimens on the scatter diagrams (Figure 10c). Two unusual specimens with finely dissected fronds and with 32 spores, from Riversleigh near the Northern Territory – Queensland border, have also been placed in *C. brownii*. These may be hybrids of *C. brownii* with another species, perhaps *C. sieberi*, though we have no cytological evidence to confirm such a hypothesis.

Cheilanthes brownii can also be confused with very hairy specimens of *C. hirsuta* and *C. prenticei*; however, the two latter species characteristically have fringes of hairs on the pinnule margins, whereas *C. brownii* does not.

Green (1988) changed the authority of *Cheilanthes brownii* from (Desv.) Domin to (Kuhn) Domin. The change was based on the illegitimacy of the two names *Notholaena brownii* Desv. and *N. vellea* (Ait.) Desv. Domin (1915) had used the former as basionym for his new combination, *Cheilanthes brownii*, when he should have used *Gymnogramme brownii* Kuhn, which he had listed as a synonym.

SELECTED SPECIMENS: WESTERN AUSTRALIA: 18.5 km NW of Wongan Hills towards Piawaning, *R.G. Coveny 7856 & B.R. Maslin*, Aug 1976 (NSW, CANB); Wolf Creek Meteorite Crater, c. 85 km S of Halls Creek, Kimberleys, *A.C. Beauglehole 47386 & G. Carr 3608*, July 1974 (AD, PERTH); Wolf Creek Crater, *B. Maloney 5*, July 1977 (NSW). NORTHERN TERRITORY: 54 km S of Elliott, Stuart Highway, *J. Must 471*, Feb 1969 (DNA, NSW); 21 km W of 'Wollogorang H.S.' –'Calvert Hills road', *S. Jacobs 1567*, May 1974 (NSW); Moline Rockhole, 9 km NE of Mary River on Pine Creek – El Sharana road, *K.L. Wilson 5225*, May 1983 (NSW). QUEENSLAND: Gorge Creek 18 km W of Mareeba, *H.S. McKee 9263*, Apr 1962 (BRI, NSW); Canopy Rock, Mountain Valley Station, *R. Swinbourne 685*, Feb 1963 (NSW).

14. Cheilanthes lasiophylla *Pichi-Serm.*, Webbia 8: 209 (1951).

REPLACED NAME: *Notholaena canescens* Kunze, Ind. Sem. Hort. Lips. (1845); Linnaea 19: 406 (1847); Lehmann, Pl. Preiss. 2: 110 (1847). Non *Cheilanthes canescens* Kunze, Linnaea 13: 143 (1839).

LECTOTYPE (Pichi-Sermolli 1951): Jardin de Leipzig, raised by chance from spores brought from New Holland [Australia] by Preiss, 1846, *Kunze* (K, photo seen). ISOLECTOTYPES: G (photo seen); BR (n.v.).

[*Notholaena lasiopteris* F. Mueller, in Hooker, Journ. Bot. 5: 105 (1853), nom. nud.]

ILLUSTRATIONS: Pichi-Sermolli (1951: Figures 3–6 [figures of type specimens]); Quirk & Chambers (1978: Figures 8a–d); Quirk et al. (1983: Figures 20, 21, 42); Andrews (1990: Figure 34.2D).

Fronds to 24 cm long and 3 cm wide. *Stipe* and *rhachis* red-brown to black, with moderately dense to dense scales that have dendritic basal edges. *Lamina* elliptic or lanceolate, bipinnate at the base and for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, ovate-lanceolate, margins entire or lobed, upper surface with sparse to moderately dense slender white branched hairs, lower surface with dense hairs and very sparse scales (Figures 4c; 18). *Spores* spherical, with varying amounts of reticulate ornamentation, granulose and ridged beneath ornamentation, 45–74 µm diam., 16 per sporangium (Figure 8a). $2n$ = at least 105, Quirk et al. (1983: 531).

DISTRIBUTION AND HABITAT: Occurs in central and southern Australia from Western Australia to western New South Wales and north-western Victoria (Figure 12g). Found on rocky slopes and in rock crevices in arid inland mountain ranges or rock outcrops.

NOTES: *Cheilanthes lasiophylla* is easily distinguished from the scaly *C. distans* and the hairy *C. brownii* by the long hair-like branches that arise from the basal margins of the scales.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Dundas Rocks, 18 km S of Norseman, *A.C. Beauglehole 13153*, Sep 1965 (NSW); 6 km S of Agnew, *A.C. Beauglehole & E.G. Errey*, Sep 1978 (MEL). NORTHERN TERRITORY: Lassiters Cave, Hull River, *G. Chippendale 4615*, June 1958 (DNA, NSW, PERTH); Penny Springs, George Gill Range, *A.C. Beauglehole*, July 1968 (MEL). SOUTH AUSTRALIA: Middle Flinders Range, Chambers Gorge near Mt Chambers, *Hj. Eichler 12548*, Sep 1956 (AD, NSW); Gammon Ranges, northern Flinders Range, *Hj. Eichler*, Sep 1956 (NSW); Flinders Range, *N.F. Learmouth ACB 7568*, Sep 1956 (NSW); Upper Arkaringa Valley, *R. Helms*, May 1891 (MEL, NSW). NEW SOUTH WALES: Girilambone, *E. Betche*, Oct 1886 (NSW); Tibooburra, *E.F. Constable*, Oct 1949 (NSW). VICTORIA: 2 km N of Rockhole Bore, N of Murrayville, *T.S. Henshall*, Aug 1970 (BRI).

15. Cheilanthes distans *(R. Brown) Mettenius*, Abh. Senckenb. Naturf. Ges. 3: 69 (1859).

BASIONYM: *Notholaena distans* R. Brown, Prodr. Fl. Nov. Holl.: 146 (1810).

HOLOTYPE (Quirk et al. 1983: Figure 16): New South Wales: Port Jackson, *R. Brown 4*, 1802–5 (BM).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 7a–f); Quirk et al. (1983: Figures 16 [holotype], 17, 40); Andrews (1990: Figure 34.2B).

Fronds to 30 cm long and 3 cm wide. *Stipe* red-brown or dark brown, moderately dense to dense brown scales and some hairs. *Rhachis* colour as for stipe, with dense scales. *Lamina* linear, bipinnate or bipinnatifid at the base and for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, oblong-elliptic, margins entire or lobed, upper surface with sparse to moderately dense slender white hairs and very sparse scales, or occasionally glabrous, lower surface with sparse to dense scales and very sparse hairs (Figures 4d; 19). *Spores* spherical, echinate ornamentation, granulose and ridged beneath ornamentation, 43–79 µm diam., 16 per sporangium (Figure 8b).

Figure 18. *C. lasiophylla:* **a** habit, scale bar = 1 cm; **b** early season frond, scale bar = 1 cm; **c** frond, scale bar = 1 cm; **d** pinna upper surface, scale bar = 5 mm; **e** T.S. of fertile pinna, scale bar = 0.5 mm; **f** branched hair from lower (abaxial) pinnule surface, scale bar = 0.1 mm; **g** scale from base of stipe, scale bar = 1 mm (a,d,e,f,g: *Helms*, MEL 667615; b: *Beauglehole*, MEL 648284; c: *Beauglehole & Errey*, MEL 648276).

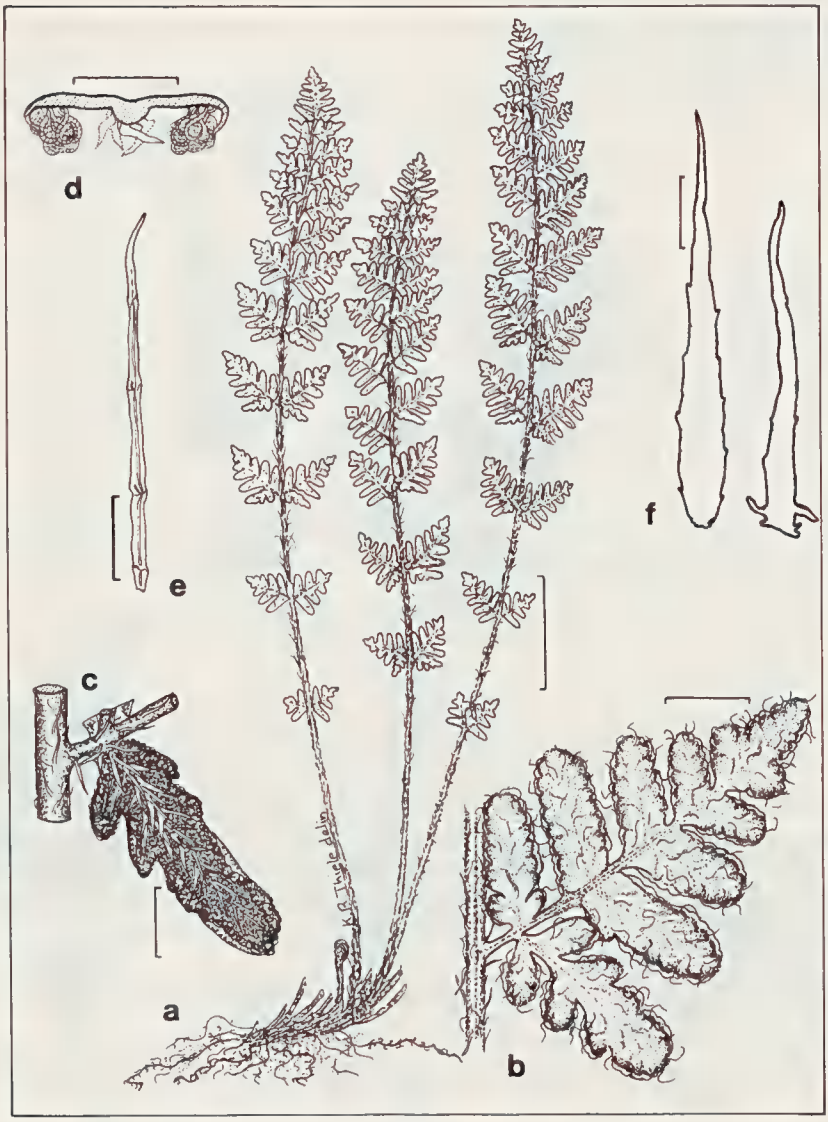

Figure 19. *C. distans*: **a** habit, scale bar = 2 cm; **b** pinna, upper (adaxial) surface, scale bar = 3 mm; **c** pinnule, lower (adaxial) surface, scale bar = 2 mm; **d** pinnule, T.S., scale bar = 1 mm; **e** hair from lower pinna surface, scale bar = 0.4 mm; **f** scales from mid-vein of pinna, scale bar = 0.5 mm (*Willis*, MEL 504710).

DISTRIBUTION AND HABITAT: Occurs in eastern Australia from Victoria (isolated occurrences) through New South Wales (abundant) to mid-northern Queensland; isolated specimens from South Australia and Western Australia; also occurs on Lord Howe Island (Figure 12h). Found in rock crevices in moderately wooded often mountainous areas. Extends to New Zealand, New Caledonia and some other Pacific islands.

NOTES: *Cheilanthes distans* is distinctive because of the simple, often coarse, scales on the lower surface (especially midrib) of the pinnae. It is most easily confused with *C. lasiophylla*, but *C. lasiophylla* has dense hairs on the lower pinnule surface and the scales on its stipe and rhachis have relatively long branches arising from their basal edges.

SELECTED SPECIMENS: WESTERN AUSTRALIA: 11.5 km N of Moora, *R.J. Chinnock 5284*, Oct 1981 (AD, NSW). SOUTH AUSTRALIA: Southern Flinders Ranges, Mambray Creek, *P. Martinsen 0060*, Sep 1974 (AD); Barossa Valley, *R.J. Chinnock 204*, July 1973 (NSW). QUEENSLAND: Mt Coolum c. 3 km S of Coolum Beach, *P.R. Sharpe 3162*, Feb 1982 (BRI, NSW); Valley of Lagoons H.S., Upper Burdekin River, *D.F. Blaxell 522*, May 1971 (NSW) [mixed collection with *C. brownii*]. NEW SOUTH WALES: Cattai Creek, Cattai, *R. Coveny 8644 & S.K. Roy*, Nov 1976 (NSW, CANB); Nandewar Mountains on Kaputar road, *J.C. Morrow 42*, Mar 1968 (NSW); 5-mile Creek, Mailmans Gap, Cocopara Nature Reserve, *J.H. Willis*, Oct 1969 (MEL). VICTORIA: 12 km from Dargo on Upper Dargo Road, *H. Quirk 1*, Feb 1975 (MEL).

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References

Baker, J.G. (1874) *Cheilanthes* and *Pellaea*. Pp. 475–478 in W.J. Hooker & J.G. Baker (eds), *Synopsis Filicum*, 2nd edn.

Brown, R. (1810) *Prodromus florae Novae Hollandiae et Insulae van-Diemen.*

Christensen, C. (1906) *Index Filicum* (Hagerup: Copenhagen).

Copeland, E.B. (1947) *Genera Filicum* (Chronica Botanica: Waltham, Mass., U.S.A.).

Desvaux, A.N. (1813) Observations sur quelques nouveaux genres de fougères et sur plusieurs espèces nouvelles de la même famille. *J. Bot. Agric.* 1: 89–93.

Domin, K. (1915) Beiträge zur Flora und Pflanzengeographie Australiens. *Bibliotheca Bot.* 85: 121–239.

Green, P.S. (1988) Notes relating to Australian ferns, especially from Norfolk & Lord Howe Islands. *Kew Bull.* 43(4): 649–657.

Hooker, W.J. (1864) *Species Filicum* vol. 5.

Jones, D.L. (1988) New fern species from northern Australia. *Austrobaileya* 2: 469–480.

Luerssen, C. (1882) Pteridologische notizen. *Bot. Centralbl.* 9: 442–443.
Manton, I., & Sledge, W.A. (1954) Observations on the cytology and taxonomy of the pteridophyte flora of Ceylon. *Phil. Trans. Roy. Soc. London (B)* 238: 127–185.
Mettenius, G. (1869) in M. Kuhn, Analecta pteridographica. *Bot. Zeitung (Berlin)* 27: 437–440.
Mickel, J.T. (1987) A new fern from western Mexico and its bearing on the taxonomy of the Cheilanthoid ferns. *Amer. Fern J.* 77(4): 109–114.
Pichi-Sermolli, R.E.G. (1951) Notes on some Australian ferns. *Webbia* 8: 205–211.
Pichi-Sermolli, R.E.G. (1970) A provisional catalogue of the family names of living pteridophytes. *Webbia* 25: 219–297.
Pichi-Sermolli, R.E.G. (1977) Tentamen Pteridophytorum genera in taxonomicum ordinem redigendi. *Webbia* 31: 313–512.
Quirk, H. & Chambers, T.C. (1978) Spore characters of the genus *Cheilanthes* with particular reference to southern Australia. *Fern. Gaz.* 11: 385–399.
Quirk, H., Chambers, T.C. & Regan, M. (1983) The fern genus *Cheilanthes* in Australia. *Austral. J. Bot.* 31: 501–553.
Rumphius, G.E. (1750) *Herbarium amboinense* vol. 6.
Tryon, R.M. & Stolze, R.G. (1989) Pteridophyta of Peru. Part II. 13. Pteridaceae – 15. Dennstaedtiaceae. *Fieldiana, Bot., New Series* No. 22.
Swartz, O. (1806) *Synopsis Filicum.*
Walker, T.G. (1979) The Cytogenetics of Ferns. Pp. 87–132 in A.F. Dyer (ed.), *The Experimental Biology of Ferns* (Academic Press: London).

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Corrigenda – *Telopea* 4(2)

L.A.S. Johnson & K.D. Hill. Systematic studies in the eucalypts – 2. A revision of the gimlets and related species: *Eucalyptus* extracodical series *Salubres* and *Annulatae* (Myrtaceae)

Page 221, par. 7, line 1 – heading should read:

E. diptera – E. tortilis [not *E. diptera – E. terebra*]

K.D. Hill & L.A.S. Johnson. Systematic studies in the eucalypts – 3. New taxa and combinations in *Eucalyptus* (Myrtaceae)

Page 234, Figure 7 – delete north-westernmost point for *E. cephalocarpa* (from a cultivated plant at Bendigo).

Page 235, par. 8 – *E. conspicua* – distribution should read:
DISTRIBUTION: NEW SOUTH WALES: South Coast, Narrabarba southwards. VICTORIA: subcoastal country east of Traralgon.

Page 237, par. 7:
E. alligatrix – distribution should read:
DISTRIBUTION: VICTORIA: Valleys on the inland side of the Great Divide, between Beechworth and the Goulburn River.

Page 256, par. 3 – *E. laophila* – replace description by the following:
Mallee to 7 m high. *Bark* smooth, grey-brown, olive and cream, shedding in strips. Juvenile leaves opposite, becoming disjunct, lanceolate, to 18 cm long, 3 cm wide, venation and oil glands distinct, lateral veins at 20–40° to midrib. *Adult leaves* disjunct, lanceolate, oblique, falcate, attenuate, coriaceous, glossy green, usually with a bluish sheen, 5–11 cm long, 4–10 mm wide; petioles flattened, 6–10 mm long; lateral and intramarginal veins indistinct; oil glands large and prominent. *Umbellasters* axillary, 7-flowereed; peduncles terete or weakly angled, 7–15 mm long; pedicels terete or vaguely angular, 1–4 mm long. *Mature buds* clavate to pyriform, verrucose, 6–9 mm long, 4–5 mm diam.; calyptra convex, obtuse, apiculate, less than ¼ as long as hypanthium. *Fruit* urceolate to cup-shaped, usually apically constricted, 4-locular, 8–11 mm long, 8–10 mm diam.; calyptra scar a narrow groove around hypanthium; stemonophore narrow, raised above disc and hypanthium; disc at first sharply depressed, becoming flat, up to 1.5 mm wide; valves fully enclosed, vertical when opened. *Seeds* grey-brown or brown, reniform, angular, to 2 mm long; chaff similar.

K.D. Hill & L.A.S. Johnson. Systematic studies in the eucalypts – 4. New taxa in *Eucalyptus* (Myrtaceae)

Page 336, last line – *E. persistens* subsp. *persistens* – description of calyptra should read: outer calyptra persistent to anthesis.

Systematic studies in the eucalypts. 5. New taxa and combinations in *Eucalyptus* (Myrtaceae) in Western Australia

K.D. Hill & L.A.S. Johnson

Abstract

Hill, K.D. & Johnson, L.A.S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney NSW Australia 2000) 1991. Systematic studies in the eucalypts. 5. New taxa and combinations in Eucalyptus *(Myrtaceae) in Western Australia.* Telopea *4(4): 561–634.* New taxa and combinations in *Eucalyptus* subgenus *Symphyomyrtus* section *Bisectaria* from Western Australia are presented (some species occur in adjacent regions of South Australia and the Northern Territory). New species described are *Eucalyptus pruiniramis, E. blaxellii, E. vegrandis, E. suggrandis* (with subsp. *alipes*), *E. goniocarpa, E. tenera, E. tephroclada, E. depauperata, E. phylacis, E. misella, E. foliosa, E. argyphea, E. recta, E. balanopelex, E. rosacea, E. educta* and *E. lata.* New subspecies are recognised in *E. loxophleba* Benth. (subsp. *supralaevis* and subsp. *lissophloia*), *E. sargentii* (subsp. *fallens*), *E. angustissima* F. Muell. (subsp. *quaerenda*), *E. mannensis* Boomsma (subsp. *vespertina*), *E. goniantha* Turcz. (subsp. *notactites*), *E. kessellii* Maiden & Blakely (subsp. *eugnosta*), *E. balladoniensis* Brooker (subsp. *sedens*), *E. leptopoda* Benth. (subsp. *arctata*, subsp. *subluta* and subsp. *elevata*) and *E. websteriana* Maiden (subsp. *norsemanica*). Taxa changed in status are *E. gratiae* and *E. semiglobosa.* A new name is provided for *E. occidentalis* var. *stenantha* (*E. aspratilis*). Taxa discussed under new circumscription are *E. spathulata* Hook., *E. eremophila* (Diels) Maiden, *E. synandra* Crisp, *E. websteriana* Maiden and *E. orbifolia* F. Muell. Misapplication of the name *E. goniantha* is corrected.

Introduction

New taxa described here are a selection from many that we have defined during our current revision of the eucalypts. These are taxa occurring in Western Australia, although some have sister taxa in South Australia and the Northern Territory. Many of these taxa are treated as undescribed species or subspecies in the semi-popular account of south-western taxa by Brooker & Kleinig (1990). The new taxa discussed both here and by Brooker & Kleinig were delineated by us during a comprehensive revisionary study of the eucalypts, and were freely discussed with Ian Brooker in order to allow the treatment in Brooker & Kleinig. A number of other new species from Western and South Australia have also been formally described by other workers (Brooker & Kleinig 1990, Brooker & Hopper 1991, Brooker & collaborators, in prep.).

At this stage, *Eucalyptus* L'Hérit. will be used in the traditional sense. The species are not allocated alphabetic codes according to the system of Pryor & Johnson (1971) since these are being revised. Species are treated in the order in which they occur in the revised classification being developed from that of Pryor & Johnson.

Rare or threatened species are allocated conservation status codes according to the system of Briggs & Leigh (1988).

We are both acquainted with all the new and related taxa in the field.

Terminology

The term 'stemonophore' is used throughout as a more acceptable combination of Greek elements than the Latin-Greek hybrid 'staminophore' (after Johnson & Briggs 1984).

The term 'calyptra' is used throughout in place of 'operculum' as traditionally used in *Eucalyptus*. The latter term has been used in *Eucalyptus* alone, whereas the former is the accepted term for the fused perianth structures occurring widely in Myrtaceae (Johnson & Briggs 1984, following McVaugh 1968).

Bark is described as 'persistent' in cases where it is not regularly shed, and 'smooth' when regularly shedding. The former includes 'stringybark', 'box' and 'ironbark' among other types, and the latter covers the 'gum' barks.

Nomenclature

Names of subgenera, sections, series and subseries used by us are intentionally published in a system (PJ) devised by Pryor & Johnson (1971) and external to the International Code of Botanical Nomenclature. This avoids the confusion created by formal recognition of 'series' and 'subseries' that were used by Maiden (1903–1933) in a loose and informal sense, and classifying according to particular organ sets rather than as taxa. Moreover, as explained previously by Pryor & Johnson (1971), it allows for clear application of names and categories. Since it has a perfectly clear formalism of its own, the term 'extracodical', rather than 'informal', is appropriate.

As in lists recently privately distributed to some eucalypt workers, subseries names here differ from those used by Pryor & Johnson in ending with '-osae'. This is because '-inae' previously used is a subtribal ending (International Code of Botanical Nomenclature, 1988, Art. 19.2).

Chippendale (1988) has followed the Pryor & Johnson classification, but simplified it in recognising one infrageneric rank only (series). This has lost much of the information contained within the Pryor & Johnson hierarchical system, and has also created considerable confusion at the rank of series by attempting to formalise Maiden's informal groupings.

Brooker & Kleinig (1990) follow the PJ system in almost all areas.

Subgenus *Symphyomyrtus*, section *Bisectaria*

All species included here are part of subgenus *Symphyomyrtus*, section *Bisectaria*. This is the largest section of the largest subgenus in *Eucalyptus*, and is substantially Western Australian in distribution. The section is characterised by the deeply divided cotyledons, but is otherwise highly diverse. A number of distinctive and clearly defined series are recognisable within *Bisectaria*, and will be discussed in more detail in a future publication.

One distinct group comprising two sister series has already been discussed (Series *Salubres* and *Annulatae*, Johnson & Hill 1991). Other groups will be revised by us in the future, and still others are under revision elsewhere. Species treated here are miscellaneous new taxa arising out of our revisionary studies. All taxa treated here have separate inner and outer calyptra, the outer (calycine) calyptra shedding early in bud development.

Series *Accedentes*

Species 1 is placed in series *Accedentes*, which is defined by the combination: pith glands present; filaments regularly inflexed; anthers oblong, dorsifixed, versatile; seeds shallowly pitted, dorsally compressed.

1. Eucalyptus pruiniramis *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. accedenti* sed characteribus sequentibus distinguitur: ramuli et alabastra etiam fructus glauci, alabastra et antherae etiam fructus majores.

Type: Western Australia: 2.5 km W of Midland Highway along turnoff 5.5 km N of Watheroo, *K.D. Hill 370, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 26 Oct 1983 (holo NSW; iso AD, BRI, CANB, MEL, PERTH).

[*Eucalyptus* sp. D of Brooker & Kleinig (1990)]

Tree to 7 m, often several-stemmed. *Bark* persistent on lower trunk or smooth; rough bark fibrous to ribbony, smooth bark white or grey to pinkish orange, powdery. *Branchlets* pruinose. *Juvenile leaves* disjunct early, ovate to orbicular, to 6 cm long, 6 cm wide. *Adult leaves* dull, grey-green, disjunct, broad-lanceolate, 8–15 cm long, 11–25 mm wide; petiole 15–25 mm long; lateral veins regular, at 40–50° to midrib. Inflorescences simple, axillary; umbellasters 7–11-flowered; peduncles flattened, 10–18 mm long, to 6 mm wide; pedicels 2–4 mm long. *Buds* ovoid to fusiform, glaucous, 14–17 mm long, 6–7 mm diam.; calyptra conical, about as long as hypanthium or slightly shorter. *Stamens* all fertile; filaments regularly inflexed; anthers oblong, dorsifixed, versatile, dehiscing through parallel slits. *Style* tip in pit in calyptra. *Fruits* 4-locular, cup-shaped to cylindrical or obconical, 10–12 mm long, 8–10 mm diam.; calyptra and stemonophore scars flat; disc depressed; valves triangular, raised, tips rim-level or exserted. *Seeds* ovoid, dorsiventrally compressed, grey-brown, very shallowly pitted; hilum ventral.

Distinguished from *E. accedens* W. Fitzg. by the glaucous twigs, buds and fruits, and the larger buds, anthers and fruits.

Distribution: Known only from scattered populations in a restricted area between Arrino and Mogumber (mainly Irwin District, into Drummond and Dale Districts). Figure 1.

Ecology: An uncommon small to medium tree or mallee, on rather nutrient-deficient, shallow soils over laterite or sandstone. It appears to hybridise in places with *E. accedens*, which also occurs in this area.

Conservation status: 2V-. Restricted and local in distribution, in an area which has suffered considerable agricultural disturbance.

The epithet is from the Latin *pruina*, rime or hoar-frost, and *ramus*, a branch, referring to the pruinose branchlets.

Selected specimens (from 7 examined): Western Australia (N to S): Arrino to Three Springs, *Johnson W49*, 11 Dec 1960 (NSW); 4.9 km N of Sykes Road, N of Mogumber, *Brooker 8521*, 23 Apr 1984 (CANB, NSW, PERTH).

***E. accedens* – *E. pruiniramis* intergrades**: 7 km N of Burma Road, *Brooker 8138a*, 27 May 1983 (CANB, NSW, PERTH); 6.8 km SE of Arrino, *Brooker 8734*, 1 Nov 1984 (CANB, NSW, PERTH); 9 km NW of Three Springs, *B. Briggs 7745, 7746, 7747 & Johnson*, 1 Oct 1984 (NSW).

Series *Loxophlebae*

Species 2 to 4 are placed in series *Loxophlebae*, which is defined by the combination:

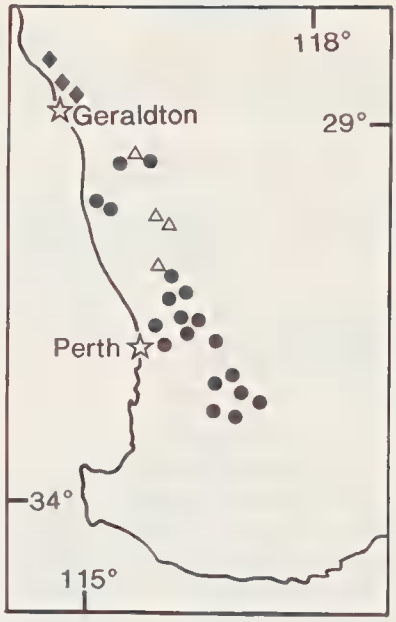

Figure 1. Distribution of *E. pruiniramis* (△), *E. accedens* (●) and *E. blaxellii* (◆).

pith glands present; adult leaves glossy, with small stomata; filaments regularly inflexed, geniculate; anthers small, cuboid, dorsifixed (often attached very low on connective), versatile; seeds shallowly pitted, dorsiventrally compressed.

2. Eucalyptus blaxellii *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. loxophlebae* sed characteribus sequentibus differt: folia juvenilia lanceolata vel late lanceolata nitentia nec glauca, venatione foliorum adultorum acuta minus irregulari. Habitus multicaulis plusminusve humilis ab eo formae sympatricae *E. loxophleba* differt.

TYPE: WESTERN AUSTRALIA: Howatharra Gap, N of Geraldton on Highway 1 (28°30' S, 114°36' E), *D.F. Blaxell 1978, L.A.S. Johnson, M.I.H. Brooker & S.D. Hopper*, 22 May 1983 (holo NSW; iso CANB, K, MEL, PERTH).

[*Eucalyptus* sp. I of Brooker & Kleinig (1990)]

Mallee to 3 m. *Bark* smooth, olive-brown to bronze. *Juvenile leaves* disjunct, semi-glossy to glossy, green, lanceolate to broad-lanceolate. *Adult leaves* disjunct, narrow-lanceolate, acuminate, glossy, 6–9 cm long, 7–16 mm wide; petioles 5–9 mm long; lateral veins moderately spaced, at 20–40° to midrib, irregular and partly broken, secondary reticulum irregular and broken; intramarginal vein distinct, 1.0–1.5 mm from margin. *Inflorescences* simple, axillary, umbellasters 7-flowered; peduncles terete or slightly angular, 3–6 mm long; pedicels slightly angular, 1–3 mm long. *Mature buds* ovoid-cylindrical, 7–8 mm long, 3–4 mm diam.; calyptra hemispherical, hypanthium 2–3 times longer than calyptra; filaments regularly inflexed, constricted (geniculate) at point of flexure; style constricted at base. *Fruits* cup-shaped to conical, 5–6 mm long, 4–6 mm diam., 4–5-locular; calyptra scar flat, c. 0.5 mm wide; disc vertically depressed, 1.0–1.5 mm wide; valves triangular, enclosed, held ± horizontally. *Seeds* elliptic, grey-

brown, shallowly reticulate, c. 1.5 mm long; hilum ventral; chaff smaller, paler. Figure 2.

This taxon is nearest the *E. loxophleba* group of taxa (including *E. gratiae*, discussed below). It is distinguished from that group by the lanceolate to broad-lanceolate, green juvenile leaves, the absence of pruinosity, the acute, not strongly irregular venation, and the mostly simple, axillary inflorescences.

Distribution: Known from two or three small populations in the Howatharra Gap area and north-east along the Moresby Range, from Geraldton to north of Northampton (Irwin District). Figure 1.

Ecology: *E. blaxellii* occurs around breakaways in low sandstone hills, growing in mallee heath with a wide variety of scleromorphic shrub species.

Conservation status: 2E (*Eucalyptus* sp. 22, Briggs & Leigh 1988, p. 119).

The specific epithet honours our colleague Donald F. Blaxell, Assistant Director (Living Collections) at the Royal Botanic Gardens, Sydney, who first noted the distinctive nature of this species in the course of his extensive field studies of the eucalypts.

Selected specimens (from 16 examined): Western Australia (N to S): Rob Road, 0.4 km W of Pt Gregory road, *Brooker 9277*, 8 May 1986 (CANB, NSW, PERTH); Nanson Road, *Brooker 9193*, 12 Mar 1985 (CANB, NSW, PERTH); 9 miles [14 km] NE of Geraldton on Yuna road, *Chippendale 320*, 16 Mar 1968 (CANB, NSW).

3. Eucalyptus loxophleba *Benth.*, Fl. Austral. 3: 252 (1867).

Type citation: 'W. Australia. Swan River and Darling range, Collie; Drummond, 2nd Coll. n. 82; York district, Preiss, n.246 (and 248?); Murchison river and Champion Bay, 'York Gum', Oldfield.'

Type: Western Australia: Swan River Colony, *J. Drummond, 2nd collection, no. 82*, 1843 (lecto K; isolecto BM, CGE, E, G, NSW, W). A fragment in NSW, which was a part of the K specimen, is annotated in Maiden's handwriting 'Drummond's 82 is the type.' This collection is here designated the lectotype.

≡ *E. foecunda* Schauer var. *loxophleba* (Benth.) Luehm. ex Maiden, Crit. Revis. Eucalyptus 1: 112, pl. 23, figs. 1–3; pl. 24 (1904).

Regarded as a variety of *E. foecunda* by Luehmann (1898) and Maiden (Crit. Revis. Eucalyptus 1: 112 (1904)), but again recognised as a species by Blakely (1934).

Tree to 15 m or mallee to 8 m. *Bark* persistent to smaller branches or partly smooth, rough bark grey, shortly fibrous-flaky, smooth bark brownish, yellow-brown or greenish, smaller twigs glaucous. *Juvenile leaves* petiolate, ovate to orbicular, acute to rounded, dull, bluish, 8–13 cm long, 5–9 cm wide. *Adult leaves* glossy, lanceolate to broad-lanceolate, falcate, acute, 6–14 cm long, 10–25 mm wide; petioles 10–18 mm long; lateral veins at 10–30° to midrib and highly irregular. *Umbellasters* axillary, 7-flowered or often more, often clustered at leafless ends of small branches; peduncles 2-angled, 3–24 mm long; pedicels grooved, 2–5 mm long. *Mature buds* obovoid, 6–10 mm long, 3–4 mm diam.; calyptra shorter than hypanthium, hemispherical, rarely apiculate; filaments regularly inflexed, constricted (geniculate) at point of flexure; style constricted at base. *Fruits* conical, sometimes vaguely angular, 3–4-locular, 4–9 mm long, 4–6 mm diam.; disc narrow, flat; valves deeply sunken. *Seeds* dull, dark brown, cuboid, to 1 mm long; chaff similar, thinner, or linear, to 4 mm long.

Distinguished within the series by the combination: juvenile leaves ovate to orbicular, dull, bluish; adult leaves lanceolate to broad-lanceolate, glossy, venation acute, highly irregular; inflorescences aggregated onto short, leafless shoots.

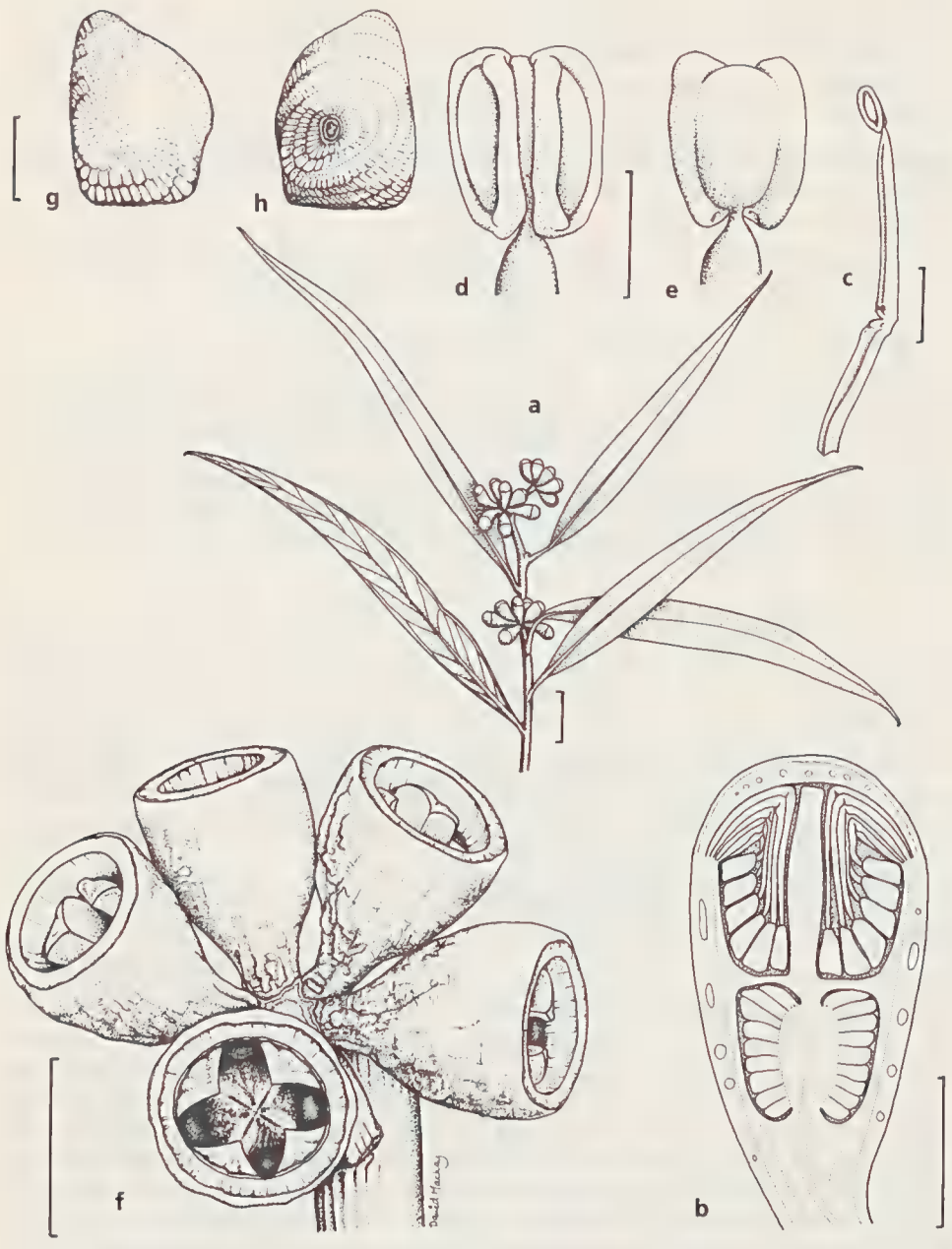

Figure 2. *E. blaxellii*. **a**, adult leaves and buds; **b**, section of bud; **c**, filament showing flexure; **d**, **e**, anther; **f**, fruits; **g**, **h**, seed (all from *Blaxell 1978*). Scale bar: a = 1 cm; f = 5 mm; b = 2 mm; c = 1 mm; d, e, g, h = 0.5 mm.

Three geographic subspecies may be recognised within this taxon.

1 Tree; bark persistent at least on lower trunk

2 Bark persistent to small branches ..... **3a.** subsp. **loxophleba**

2* Bark smooth on larger branches and often upper trunk **3b.** subsp. **supralaevis**

1* Mallee; bark wholly smooth ..... **3c.** subsp. **lissophloia**

3a. Eucalyptus loxophleba *Benth.* subsp. **loxophleba**

[*E. amygdalina* Schauer in Lehm., Pl. Preiss. 1: 130 (1844); non Labill., Nov. Holl. Pl. 2: 14 (1806). Based on *Preiss 246* & *248* from York, which were included in *E. loxophleba* by Bentham (1867: 254).]

Tree to 15 m. *Bark* persistent to smaller branches, grey, fibrous-flaky; smaller twigs not or very slightly glaucous. *Juvenile leaves* petiolate, ovate to orbicular, acute to rounded, dull, bluish, to 12 cm long, 5 cm wide. *Adult leaves* glossy, lanceolate, falcate, acute, 6–10 cm long, 10–25 mm wide. *Peduncles* 2-angled, 7–12 mm long; pedicels grooved, 2–5 mm long. *Mature buds* obovoid, c. 6 mm long, c. 4 mm diam. *Fruits* conical, 4-locular, 6–8 mm long, 4–6 mm diam.

Distinguished by the combination: tree habit; bark persistent to smaller branches; twigs not or scarcely glaucous. Fruits are relatively small within the species.

Distribution: A species of the Wheat Belt, from around Moora to Bruce Rock, south-east to around Chillinup on the Pallinup River (Avon, Dale, Roe and Eyre Districts). Figure 3.

Ecology: A common tree of the higher rainfall and higher-nutrient soils of the wetter western parts of the Wheat Belt.

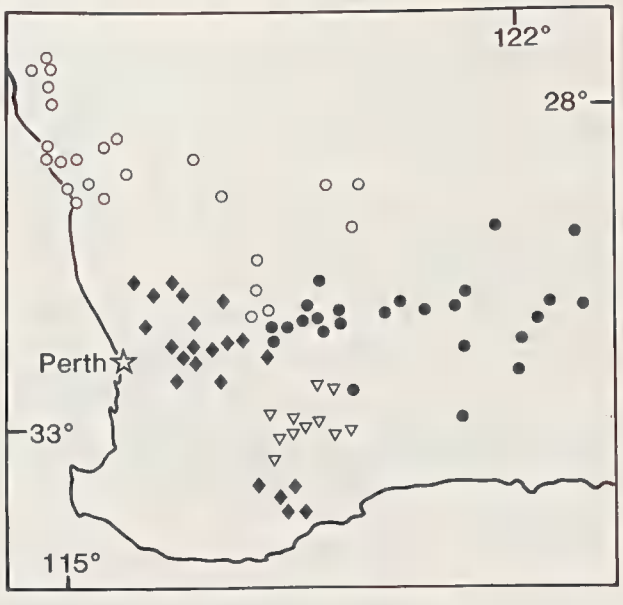

Figure 3. Distribution of *E. loxophleba* subsp. *loxophleba* (◆), subsp. *supralaevis* (○), subsp. *lissophloia* (●) and *E. gratiae* (▽).

Intergrades occur with subsp. *supralaevis* where the ranges join, and hybrids are recorded with *E. erythronema* Turcz. (sens. lat.), *E. spathulata*, *E. vegrandis* and *E. wandoo* Blakely.

Conservation status: Not considered to be at risk.

Selected specimens (from 47 examined): Western Australia: 7 miles [11 km] NW of Wongan Hills, *Tindale 2795*, 24 Aug 1973 (NSW, CANB, PERTH); 0.9 km W of Highway 95 on Gin Gin road, *Hill 2963*, 30 Aug 1988 (NSW); Bindoon, *Johnson W 7*, 9 Dec 1960 (NSW); near Northam, *Morrison*, Aug 1959 (NSW); near York, *Diels 2914*, 24 May 1901 (B, NSW); 67 km ESE of Perth on Brookton road, *Blaxell W75/4*, 2 Oct 1975 (NSW); Cowcowing, *Koch 1094*, Sep 1904 (NSW); Cunderdin, *Beadle 105*, 25 Oct 1972 (NSW); Meares Lake, c. 10 miles [16 km] E of County Peak, Beverley, *St Barbe Moore per Sargent 706*, Oct 1910 (NSW); 4 km NW of Ongerup, on Newbey's property, *Hill 336, Johnson & Blaxell*, 23 Oct 1983 (NSW); 1 km N of Chillinup, *B. Briggs 7879 & Johnson*, 11 Oct 1984 (NSW).

Intergrades between subsp. *loxophleba* and subsp. *supralaevis*: Western Australia: 10–15 km SW of Three Springs on Eneabba road, *Foreman 539*, 4 Sep 1984 (MEL, AD, CANB, NSW, PERTH); 28.6 miles [45.8 km] W of Watheroo, *Chippendale 26*, 18 Oct 1966 (CANB, NSW).

***E. erythronema* (sens. lat.) x *E. loxophleba* subsp. *loxophleba*:** North Bungulla Nature Reserve, *Brooker 9729*, 23 July 1987 (CANB, NSW, PERTH).

***E. loxophleba* subsp. *loxophleba* x *E. spathulata*:** 0.5 km W of Eldridge St on main road, Ongerup, *Brooker 9638*, 18 May 1987 (CANB, NSW, PERTH).

***E. loxophleba* subsp. *loxophleba* x *E. vegrandis*:** 4 km NW of Ongerup, *Hill 334, Johnson & Blaxell*, 23 Oct 1983 (NSW).

***E. loxophleba* subsp. *loxophleba* x *E. wandoo* subsp. *pulverea*:** S of Eneabba Nat. Res., *Hopper & Brooker 10084*, 20 Sep 1988 (CANB, NSW, PERTH); c. 7 miles [11 km] N of Watheroo, *Johnson W 22*, 9 Dec 1960 (NSW).

***E. loxophleba* subsp. *loxophleba* x *E. wandoo* subsp. *wandoo*:** 5.6 km from Irishtown Hall on Dumbarton road, *Brooker 9585*, 23 Apr 1987 (CANB, NSW, PERTH); Clackline, *Brooker 9586*, 23 Apr 1987 (CANB, NSW, PERTH).

3b. Eucalyptus loxophleba *Benth.* subsp. **supralaevis** *L. Johnson & K. Hill*, **sp. nov.**

Inter subspecies *E. loxophlebae* combinatione sequenti characteribus distinguitur: habitus arborescens; cortex ramorum laevis; ramuli plusminusve pruinosi; pedicelli graciles, mediocres vel longi; ovarium 3–4-loculare.

Type: Western Australia: 16.6 km W of highway on fence line 57.7 km N of Murchison River, *K.D. Hill 2569, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 21 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

≡ *E. loxophleba* Benth. var. *fruticosa* Benth., Fl. Austral. 3: 252 (1867).

Type citation: 'Murchison river, Oldfield; Salt river, Maxwell.'

Type: Western Australia: Murchison River, *A. Oldfield* (lecto NSW; isolecto K, MEL; here designated). This specimen is designated the lectotype in order to fix this name to this taxon, the original syntypes representing two different subspecies (the Maxwell collection is subsp. *loxophleba*). This variety was included in *E. foecunda* var. *loxophleba* by Maiden (Crit. Revis. Eucalyptus 1: 112 (1904)), recognised as a variety by Blakely (1934), and included in *E. loxophleba* by Hall & Johnston (1964).

Tree to 15 m. *Bark* persistent to around top of trunk, grey, fibrous-flaky; branches smooth, smaller twigs glaucous. *Juvenile leaves* petiolate, ovate to orbicular, acute to rounded, dull, bluish, to 12 cm long, 5 cm wide. *Adult leaves* glossy, lanceolate, falcate, acute, 6–10 cm long, 10–25 mm wide; petioles 10–18 mm long; lateral veins at 10–30°

to midrib. *Peduncles* 2-angled, 7–12 mm long; pedicels grooved, 2–5 mm long. *Mature buds* obovoid, c. 6 mm long, c. 4 mm wide. *Fruits* conical, 3–4-locular, 6–8 mm long, 4–6 mm diam.

Distinguished by the combination of tree habit and the smooth bark from the top of the trunk. The twigs are variably glaucous, but usually distinctly so. Pedicels are slender and medium to long, and the ovary is 3–4-locular (tending to 3-locular in the north of the range).

Distribution: Widespread and common across the north of the range of the species, from the region between north of the Murchison River (27°S) and around Dongara on the coast east to Lake Barlee and the Die Hardy Range, and south to Wongan Hills and Kunoppin (Irwin, Avon, Austin and Coolgardie Districts). Figure 3.

Ecology: Locally abundant on deeper, loamy, often red soils on flat sites.

Conservation status: Widespread, not considered to be at risk.

The epithet is derived from Latin *supra*, above, and late Latin *laevis* (classically *levis*), smooth, in reference to the partly deciduous bark leaving the branches and sometimes the upper trunk smooth.

Selected specimens (from 40 examined): Western Australia: 34 km S of Wannoo, *Blaxell W75/109 & Brooker*, 9 Oct 1975 (NSW, CANB); 6 miles [10 km] E of Pindar, *Beard 6680*, 26 Sep 1973 (PERTH, NSW); 27.6 km N of Burnerbinmah turnoff on Paynes Find – Yalgoo road, *Hill 2582 & Johnson*, 24 Nov 1986 (NSW, CANB, CBG, MEL, PERTH); 4 miles [6 km] E of Geraldton, *Chippendale 239*, 8 Aug 1967 (CANB, NSW); near Mingenew, *Diels 3037*, 9 June 1901 (B, NSW); Dongara, *Maiden*, Oct 1909 (NSW); summit of Mt Singleton, *Hill 2591 & Johnson*, 24 Nov 1986 (NSW, PERTH); Cliff Head turnoff on Brand Highway, *Brooker 8633*, 28 Aug 1984 (CANB, NSW, PERTH); between Beacon and Mt Churchman, *Brooker 8495*, 16 Mar 1984 (CANB, NSW, PERTH); 31.6 km S of Diemals–Menzies road on Bullfinch road, *Hill 2613 & Johnson*, 25 Nov 1986 (NSW, PERTH); 3 km E of Kununoppin, *Hill 2500, Johnson & Blaxell*, 16 Nov 1986 (NSW, PERTH).

3c. Eucalyptus loxophleba *Benth.* subsp. **lissophloia** *L. Johnson & K. Hill*, **subsp. nov.**

Inter subspecies *E. loxophlebae* habitu pluricauli, cortice deciduo, ramulis plerumque valde pruinosis distinguitur. Ab subspecie *loxophleba* alabastris fructibusque majores differt.

Type: Western Australia: Cardunia Rocks, *D.F. Blaxell 1749 & L.D. Pryor*, 16 Sep 1978 (holo NSW; iso CANB, K, PERTH).

Mallee to 8 m. *Bark* smooth, brownish, yellow-brown or greenish to bronze, smaller twigs glaucous. *Juvenile leaves* petiolate, ovate to orbicular, acute to rounded, dull, bluish, to 12 cm long, 9 cm wide. *Adult leaves* glossy, lanceolate, falcate, acute, 8–14 cm long, 10–15 mm wide; petioles 10–18 mm long; lateral veins at 10–30° to midrib. *Peduncles* 2-angled, 8–18 mm long; pedicels grooved, 2–5 mm long. *Mature buds* obovoid, 6–10 mm long, 3–4 mm wide. *Fruits* cup-shaped to conical, 4-locular, 6–9 mm long, 4–6 mm diam. Figure 4.

Distinguished by the mallee habit, the mostly or entirely smooth bark, and the usually strongly glaucous branchlets. Buds and fruits are larger than those of subsp. *loxophleba*.

Subsp. 'smooth bark' of Brooker & Kleinig (1990).

Distribution: Locally abundant through the inland southwest of Western Australia, from around Bencubbin and west of Merredin east to south of Lake Minigwal and Coonana, and south to Peak Charles (Avon, Roe, Coolgardie and southern Austin districts). Figure 3.

Figure 4. *E. loxophleba* subsp. *lissophloia*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, adult leaves and fruits; **f**, fruits (all from *Blaxell 1749*). Scale bar: a, e, f = 1 cm; b = 5 mm; c, d = 1 mm.

Ecology: A widely distributed taxon, occurring with a variety of mallee species on sandy soils, especially where these are shallow and overlie granitic rocks. Subspecies *lissophloia* does not appear to intergrade with subspecies *loxophleba* or with subspecies *supralaevis* to any great extent.

Hybrids are known with *E. kruseana* F. Muell. This hybrid was named *E. brachyphylla* C. Gardner, though it was regarded as a distinct species by its author. It was also treated as such by Chippendale (1988). Field observations show a full range of variation between the parent species, and progeny trials show segregation between the parents (Pryor & Blaxell, pers. comm. & in prep.). Limited intergradation also occurs between *E. loxophleba* subsp. *lissophloia* and *E. gratiae* (Brooker) L. Johnson & K. Hill.

Conservation status: Not considered to be at risk.

The epithet is from the Greek *lissos*, smooth, and *phloios*, bark of tree, in reference to the distinctive smooth bark of this subspecies.

Selected specimens (from 38 examined): Western Australia: 3 miles [5 km] SW of Merredin, *Chippendale 80*, 6 Mar 1967 (CANB, NSW); 6.4 km N of Southern Cross, *Brooker 6475*, 24 Aug 1979 (CANB, NSW, PERTH); 61 km W of Coolgardie on Southern Cross road, *Brooker 5665*, 6 Apr 1977 (CANB, NSW, PERTH); E side of Peak Charles, *Hill 2331, Johnson & Blaxell*, 8 Nov 1986 (NSW, PERTH); 55.8 km E of highway in Goongarrie Reserve, *Brooker 9091*, 13 Nov 1985 (CANB, NSW, PERTH); 26.7 km E of Norseman on highway, *Hill 677A & Blaxell*, 14 Nov 1983 (NSW, CANB, PERTH); 51.7 km E of Karonie, *Hill 567, Johnson, Blaxell, Brooker & Hopper*, 5 Nov 1983 (NSW, CANB, PERTH).

***E. kruseana* x *E. loxophleba* subsp. *lissophloia*:** c. 40 km E of Widgiemooltha on road to 'Binnerinjie' homestead, *Blaxell 1662*, 21 June 1978 (NSW); Cardunia Rocks, *Blaxell 1654 & Pryor*, 20 June 1978 (NSW).

***E. gratiae* x *E. loxophleba* subsp. *lissophloia*:** cited under *E. gratiae*.

4. Eucalyptus gratiae *(Brooker) L. Johnson & K. Hill*, **comb. nov.**

Basionym: *Eucalyptus loxophleba* Benth. subsp. *gratiae* Brooker, Nuytsia 1: 248 (1972).

Type citation: 'Type: 0.5 mile west of Burngup, Western Australia (33°01'S, 118°41'E), 3 Nov. 1969, *M.I.H. Brooker 2273* (holo: PERTH).'

Mallee to 8 m. *Bark* smooth, brownish, yellow-brown or greenish to bronze, smaller twigs glaucous. *Juvenile leaves* petiolate, ovate to orbicular, acute to rounded, dull, bluish, 8–13 cm long, 5–9 cm wide. *Adult leaves* glossy, lanceolate, falcate, acute, 8–16 cm long, 15–28 mm wide; petioles 10–18 mm long; lateral veins at 10–30° to midrib. *Umbellasters* axillary, 7-flowered, often clustered at leafless ends of small branches; peduncles 2-angled, 3–24 mm long; pedicels grooved, 2–5 mm long. *Mature buds* obovoid, 9–15 mm long, 4–5 mm diam.; calyptra shorter than hypanthium, hemispherical, rarely apiculate. *Fruits* conical, 4–5-locular, 9–12 mm long, 6–9 mm diam.; disc narrow, flat; valves deeply sunken. *Seeds* dull, dark brown, cuboid, to 1.5 mm long; chaff similar, thinner, or linear, to 4 mm long.

Distinguished by the mallee habit, the smooth bark, the glaucous branchlets, and the large buds and fruits. *E. gratiae* is in part broadly sympatric with *E. loxophleba* subsp. *loxophleba*, occupying sites with poorer or shallower soils. The two do not appear to interbreed, although limited intergradation occurs with *E. loxophleba* subsp. *lissophloia* where ranges adjoin. *E. gratiae* is also morphologically more distinct from the subspecies of *E. loxophleba* than these are from each other, and is hence raised to specific rank.

Distribution: Locally abundant in the south-eastern Wheat Belt, around the area including Pingrup, Lake Grace, Hyden and Newdegate (Roe District). Figure 3.

Ecology: Largely restricted to mallee shrublands on less fertile soils, often on lower areas or shallow soils.

Conservation status: Not considered to be at risk.

Selected specimens (from 14 examined): Western Australia (W to E): 5.6 km N of Nyabing towards Kukerin, *Brooker 9142*, 9 Dec 1985 (CANB, NSW, PERTH); 14 km N of Lake Grace township, *Hill 327, Johnson & Blaxell*, 23 Oct 1983 (NSW, CANB, PERTH); 15 km E of Hyden on Lake King road, *Brooker 6322*, 12 Aug 1979 (CANB, NSW, PERTH); 4.1 km N of Giles Road on Magenta Road, *Hill 3142*, 7 Sep 1988 (NSW); 15.5 miles [25 km] W of Lake King township, *Chippendale 224*, 17 Mar 1967 (CANB, NSW).

***E. gratiae* x *E. loxophleba* subsp. *lissophloia*:** Dragon Rock, *Hill 2473, Johnson & Blaxell*, 14 Nov 1986 (NSW, PERTH).

Series *Astringentes*

Species 5 and 6 are placed in series *Astringentes*, which is defined by the combination: pith glands present; adult leaves glossy, green, with small stomata; filaments erect; anthers oblong, dorsifixed, versatile; stemonophore narrow; seeds shallowly pitted, dorsiventrally compressed. The extracodical series epithet *Astringentes* (referring to the included species *E. astringens* (Maiden) Maiden) is here substituted for 'Occidentales' as used by Pryor & Johnson (1971), to preserve the independence of the extracodical system by avoiding confusion with Ser. *Occidentales* Blakely (used by Chippendale, 1988), which includes a quite different group of species of subgenus *Eucalyptus* ('Monocalyptus'). The extracodical epithet *Occidentalosae* for the subseries including *E. occidentalis* can remain.

5. Eucalyptus aspratilis *L. Johnson & K. Hill*, **nom. et stat. nov.**

≡ *Eucalyptus occidentalis* Endl. var. *stenantha* Diels ex Blakely, Key Eucalypts: 110 (1934).

Type citation: 'W.A. – Lake Cowan.'

Type: Western Australia: near Lake Cowan, *Diels 5245*, 1 Nov 1901 (holo NSW).

[*E. occidentalis* Endl. var. *stenantha* Diels ex Maiden, Crit. Revis. Eucalyptus 4: 147 (1919), nom. prov.]

≡ *E. occidentalis* Endl. var. *grandiflora* Maiden, Crit. Revis. Eucalyptus 4: 149 (1919).

Type citation: 'Kurrawang, W.A. (Dr. J.B. Cleland.) Type of var. *grandiflora*' (legend to pl. 150).

Type: Western Australia: Kurrawang, *J.B. Cleland 8161/15*, Sep 1915 (holo: NSW).

≡ *E. eremophila* (Diels) Maiden var. *grandiflora* Maiden, Crit. Revis. Eucalyptus 7: 22 (1923).

Mallee to 5 m. *Bark* usually persistent on trunk, fibrous-scaly and shaggy; smooth above, grey and light brown. *Adult leaves* disjunct, lanceolate to ovate-lanceolate, acuminate, 5–12 cm long, 10–30 mm wide; petioles 9–22 mm long, slightly flattened; lateral veins indistinct, well-spaced, at 20–60° to midrib, irregularly branched; intramarginal vein indistinct. *Umbellasters* axillary, 7-flowered; peduncles 2-angled or somewhat flattened apically, 1.6–2.3 cm long, to 4 mm wide, often reflexed; pedicels angled, 6–11 mm long. *Mature buds* 25–33 mm long, 5–6 mm diam.; calyptra cylindrical, obtuse, slightly flared at base, narrower than hypanthium, 2–3 times longer than hypanthium. *Fruits* elongate, cup-shaped or pyriform, 4- or 5-locular; hypanthium

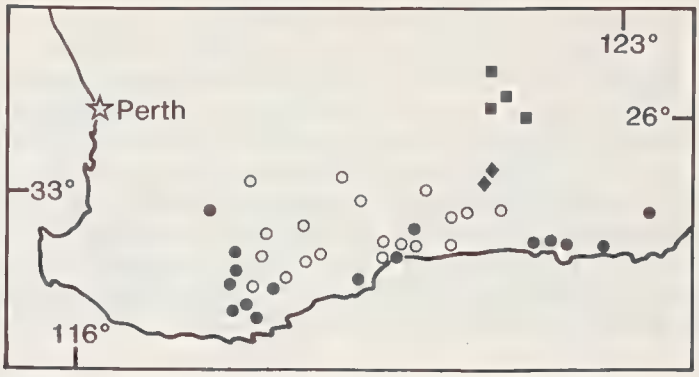

Figure 5. Distribution of *E. occidentalis* (●), *E.* species F (○), *E. aspratilis* (■) and *E. aspratilis* – *E.* species F intergrades (◆).

11–14 mm long, 8–10 mm wide; calyptra scar c. 1 mm wide, appearing continuous with disc; disc broad, initially slightly raised, ultimately strongly incurved for more than half its width, and enclosing valve bases; valves narrowly triangular, vertically exserted, strongly acuminate. *Seeds* dark brown, satiny, angular, cuboid, to 2 mm long; chaff dull, brown, either cuboid, to 1 mm long, or linear, to 4 mm long.

Distinguished within the series *Occidentales* by the mallee habit and the persistent bark on the trunk. Anthers are relatively large in comparison with those of related species.

Distribution: An uncommon species in the region south from around Coolgardie to east of Norseman (Coolgardie District). Figure 5. A disjunct population around Peak Charles is intermediate between this taxon and *E.* species F of Brooker & Kleinig (1990).

Ecology: Restricted to mallee heath communities on shallow sandy soils around granite domes.

Conservation status: 3R-. Although widely scattered, *E. aspratilis* is restricted to a very narrow habitat range.

The epithet is from the Latin *aspratilis*, rough, referring to the persistent bark, in contrast to that of the related *E.* species F.

Selected specimens (from 7 examined): Western Australia (N to S): Twenty-five Mile Rocks, *Brooker 8902*, 7 Apr 1985 (CANB, NSW, PERTH); Burra Rock, *Hill 2636 & Johnson*, 26 Nov 1986 (NSW, PERTH); 52.5 km W of Coolgardie–Norseman road on Hyden track, *Hill 2854*, 25 Aug 1988 (NSW).

***E. aspratilis* – *E.* species F intergrade:** E side of Peak Charles, *Hill 2333, Johnson & Blaxell*, 8 Nov 1986 (NSW, PERTH).

6. Eucalyptus sargentii *Maiden*, Crit. Revis. Eucalyptus 7: 58 (1924).

Type citation: 'Type – Meare's Lake, County Peak, Beverley, Western Australia, O.H. Sargent. No. 707.'

Type: holo NSW; iso CANB.

Tree to 12 m or mallee. *Bark* usually persistent on lower of trunk, dark grey to black,

coarsely platy-fibrous, smooth above, semiglossy grey, olive, red-brown or bronze. *Juveniles leaves* subsessile, opposite and lanceolate for 3–4 nodes, then becoming disjunct, linear, to 7 cm long, 3 mm wide. *Adult leaves* narrow-lanceolate, 5–10 cm long, 5–13 mm wide; petioles 8–14 mm long; lateral veins moderately spaced, at 20–40° to midrib; oil glands densely packed, spherical. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles 6–22 mm long; pedicels 3–8 mm long. *Buds* cylindrical, 16–30 mm long, 4–7 mm diam.; calyptra 3 or more times longer than hypanthium, elongate-conical, acuminate. *Stamens* all fertile; filaments erect in bud; anthers oblong, dorsifixed, versatile, dehiscing through parallel slits. *Fruits* cylindrical, usually wider at apex, to obconical, 7–12 mm long, 5–9 mm diam.; stemonophore persistent, flat; disc flat, depressed towards centre; valves erect, acicular, basally enclosed, apically exserted. *Seeds* brown to red-brown, satiny, ovoid, shallowly regularly reticulate; chaff dull.

Two geographic subspecies are recognised.

1 Buds less than 24 mm long; fruits 8 mm or less diam. ..... **6a.** subsp. **sargentii**

1* Buds more than 24 mm long; fruits 8 mm or more diam. .... **6b.** subsp. **fallens**

6a. Eucalyptus sargentii *Maiden* subsp. **sargentii**

Tree to 12 m, rarely a mallee. *Bark* persistent on lower trunk. *Adult leaves* narrow-lanceolate, 6–10 cm long, 5–13 mm wide; petioles 8–12 mm long. *Peduncles* 6–22 mm long; pedicels 3–5 mm long. *Buds* cylindrical, 16–23 mm long, 4–5 mm diam. *Fruits* cylindrical to obconical, 7–10 mm long, 5–8 mm diam.

DISTRIBUTION: From Coorow to Lake Meares, east to Lake Hurlstone (Avon and Roe Districts). Figure 6.

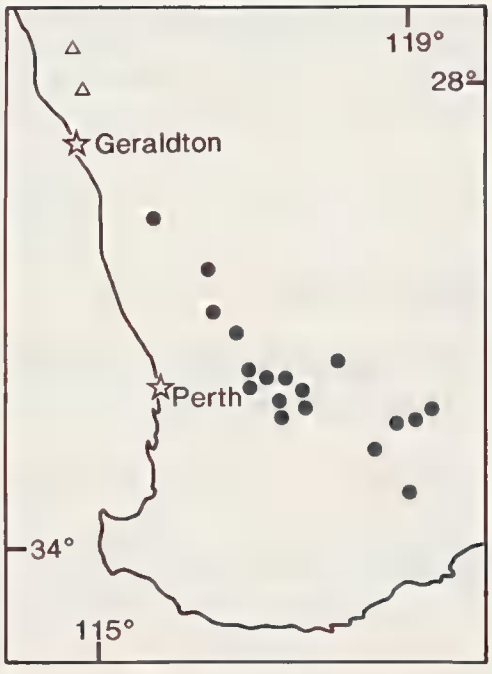

Figure 6. Distribution of *E. sargentii* subsp. *sargentii* (●) and subsp. *fallens* (△).

Ecology: Sporadically distributed but locally abundant in highly saline situations bordering salt lakes and swamps.

Conservation status: Not considered to be at risk.

Selected specimens (from 27 examined): Western Australia (W to E): Woollberoo, ESE of Coorow, *Brooker 9058*, 3 Nov 1985 (CANB, NSW, PERTH); 11.8 km E of rail crossing at Carani, *Brooker 7582*, 26 Aug 1982 (CANB, NSW, PERTH); 1.0 km W of Kauring rail crossing on York road, *Hill 2965*m 30 Aug 1988 (NSW); 8 miles [c. 12 km] SSE of Dangin, *Johnson W117*, 14 Dec 1960 (NSW); saltflats near Quairading, *Blaxell W75/80 & Brooker*, 4 Oct 1975 (NSW, CANB, K, PERTH); 7.9 km W of Pingaring, *Brooker 9478*, 21 Oct 1986 (CANB, NSW, PERTH); 12.1 km N of Ryans Road on Lockhart Road, *Hill 3140*, 7 Sep 1988 (NSW); 2.3 km E of Ravensthorpe road on Holland track, *Hill 2475, Johnson & Blaxell*, 14 Nov 1986 (NSW, CANB, CBG, MEL, PERTH).

6b. Eucalyptus sargentii *Maiden* subsp. **fallens** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie *sargentii* alabastris fructibusque majoribus distinguitur.

Type: Western Australia: 3 km N of Binnu on Highway 1, *K.D. Hill 2565, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 21 Nov 1986 (holo NSW; iso PERTH).

Tree to 6 m or mallee. *Bark* persistent on base of trunk in larger individuals only. *Adult leaves* narrow-lanceolate, 5–8 cm long, 6–12 mm wide; petioles 9–14 mm long. *Peduncles* 12–16 mm long; pedicels 4–8 mm long. *Buds* cylindrical, 25–30 mm long, 6–7 mm diam. *Fruits* cylindrical to obconical, 10–12 mm long, 8–9 mm diam. Figure 7.

Distinguished from subsp. *sargentii* by the larger buds and fruits (buds 16–23 mm long, 4–5 mm diam., fruits 7–10 mm long, 5–8 mm diam. in *E. sargentii*). Anthers in the Binnu population are larger than those of subsp. *sargentii*.

Distribution: Known from two populations, near Binnu, and about 60 km north of there on Eurardy Station (Irwin District). Figure 6.

Ecology: Restricted to somewhat saline soils around salty swamps or creek lines.

No intergrades occur with the more southerly *E. sargentii*, which, though somewhat variable in size of its parts, does not exhibit any widespread clinal approach to subsp. *fallens*.

Conservation status: 2R-.

The epithet is from the Latin *fallens*, in its sense of 'deceiving', since on its earlier observations it was mistaken for a species of the *E. eremophila* group.

Selected specimens (from 5 examined): Western Australia: Bungabandi Creek, *Brooker 9471*, 9 Oct 1986 (CANB, NSW, PERTH); 3 km N of Binnu, *Brooker 9063*, 4 Nov 1985 (CANB, NSW, PERTH).

Series *Erythronemae*

Together with others to be described elsewhere, species 7 to 14 are placed in series *Erythronemae* subseries *Platypodosae*, defined by the combination: pith glands present; stomata large, translucent; filaments erect well before maturity of the bud; anthers oblong, dorsifixed, versatile; stemonophore broad; seeds distinctly reticulately pitted, dorsiventrally compressed.

7. Eucalyptus spathulata *Hook.*, Hooker's Icon. Pl. 7: t. 611 (1844).

Type citation: 'Hab. Swan River. Jas. Drummond, (Suppl. Coll. n. 20).'

Type: Western Australia: Swan River Colony, *J. Drummond, supplementary collection, no. 20* (holo K).

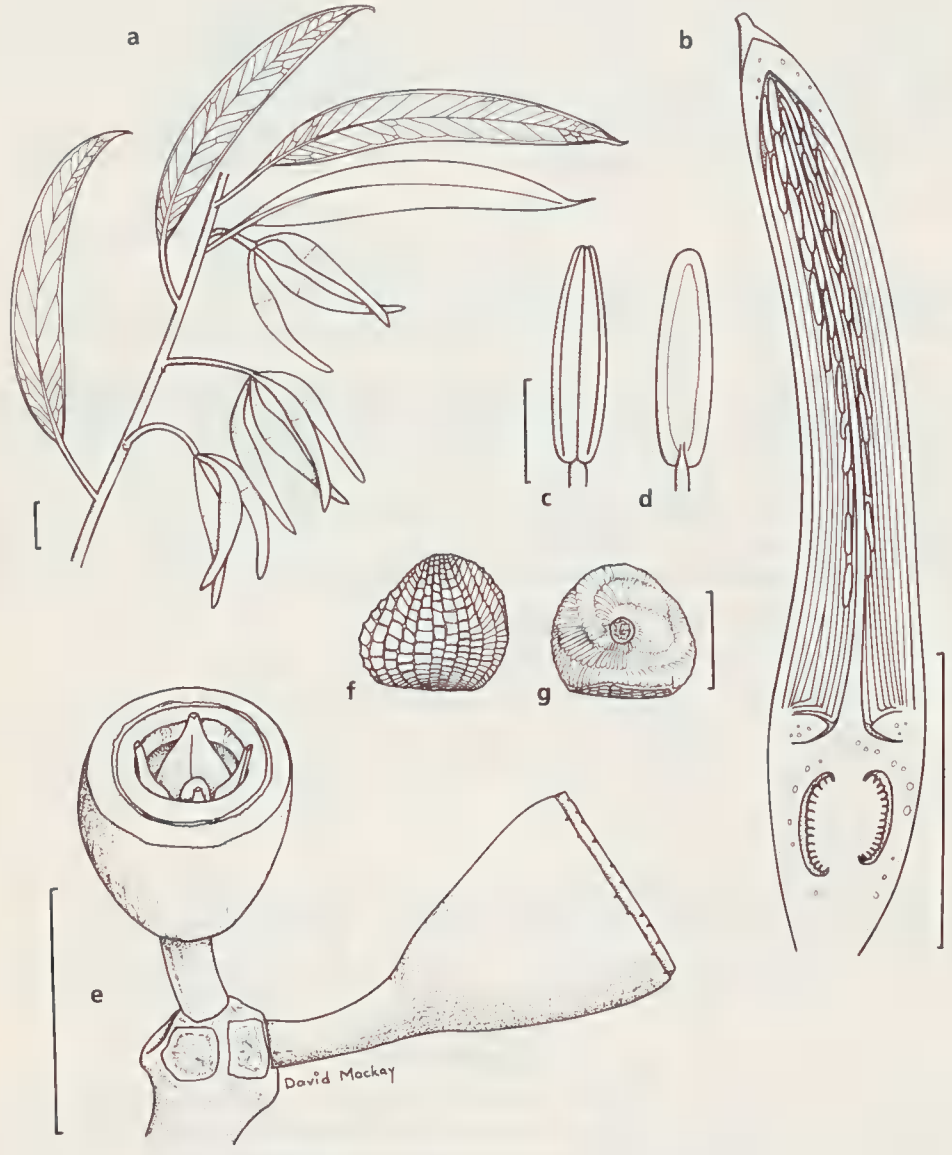

Figure 7. *E. sargentii* subsp. *fallens*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (all from *Brooker 9036*). Scale bar: a, b, e = 1 cm; c, d, f, g = 1 mm.

Tree (mallet) to 12 m. *Bark* smooth, semiglossy, dark grey to red-brown or bronze. Juvenile leaves disjunct, linear. *Adult leaves* disjunct, linear, glossy, with a distinct bluish sheen from the large translucent stomata, 5–9 cm long, 2–4 mm wide; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles flattened, 5–15 mm long; pedicels flattened or angular, 2–4 mm long. *Buds* cylindrical, 10–13 mm long, 3–4 mm diam.; calyptra more than 2 times longer than hypanthium, cylindrical, apically rounded to acute. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical or hemispherical, 4–6 mm long, 4–6 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. Figure 8.

The above description applies to a narrowed circumscription of *E. spathulata*, and is included here to allow comparison with segregate taxa described below.

The non-lignotuberous 'mallet' habit, where main branches arise acutely at more or less the same point on the trunk, occurs apparently independently in several groups of otherwise mallee species in Western Australia. *E. spathulata* in the restricted sense is an example, being a 'mallet' whereas the segregate taxa (below) are mallees. It is also more restricted in range and more specialised in habitat.

Distribution: Locally frequent, in the Tammin–Pingaring–Dumbleyung–Ongerup region (Avon and Roe Districts). Figure 9.

Ecology: Localised in mallet woodlands, on saline sites around salt pans or along drainage lines.

Intergrades occur with *E. vegrandis*, and hybrids are known with *E. loxophleba* subsp. *loxophleba* and *E. platypus* Hook. (a specimen of the latter hybrid constitutes the type of *E. platypus* Hook. var. *heterophylla* Blakely).

Conservation status: 3V. Although locally frequent, this species occurs almost entirely in agricultural country. The habitat is also very narrow, fringing saline areas. Agricultural practices are causing rapid spread of these saline areas, in many sites engulfing the habitat of this species faster than the species can propagate into the newly created fringing zones.

Selected specimens (from 15 examined): Western Australia: 4.5 km W of Tammin, *L. Johnson 9112 & M. Johnson*, 18 May 1988 (NSW, PERTH); 21.8 km S of Lake Grace, *Hill 328, Johnson & Blaxell*, 23 Oct 1983 (NSW); 24 km from Katanning on road to Nyabing, *Crisp 5195*, 16 Jan 1975 (CBG, CANB, MO, NSW, PERTH); Ongerup – Pingrup road (33°52'S 118°28'E), *Johnson 9171 a–e & B. Briggs*, 31 Oct 1988 (NSW, CANB).

***E. loxophleba* subsp. *loxophleba* x *E. spathulata*:** cited under the former.

***E. platypus* x *E. spathulata*:** 10 km NNW of Ongerup, *Hopper 2401*, 31 July 1982 (PERTH, photo NSW); near Ongerup, *Steward 133*, 30 May 1917 (NSW, type of *E. platypus* var. *heterophylla*).

***E. spathulata* – *E. vegrandis* intergrades:** Harrismith, *Gardner 2105*, 5 May 1924 (PERTH, NSW); 6 miles [10 km] N of Lake Grace, *Johnson W 235*, 19 Dec 1960 (NSW); 19 km N of Ongerup on Lake Grace road, *B.Briggs 7926 & Johnson*, 11 Oct 1984 (NSW, PERTH).

8. Eucalyptus vegrandis *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. spathulatae* sed habitu pluricauli, foliis latioribus et fructibus majoribus distinguitur.

Type: Western Australia: 5 km NW of Ongerup, *K.D. Hill 337, L.A.S. Johnson & D.F. Blaxell*, 23 Oct 1983 (holo NSW; iso CANB, PERTH)

Figure 8. *E. suggrandis* subsp. *suggrandis*. **a**, adult leaf; **b**, buds; **c**, fruits (**a**, **c** from *Blaxell 1697*, **b** from *Brooker 8659*). *E. suggrandis* subsp. *alipes*. **d**, adult leaf; **e**, buds; **f**, fruits (all from *Blaxell W75/26 & Brooker*). *E. vegrandis*. **g**, adult leaf; **h**, buds; **i**, fruits (all from *Fitzgerald*, Nov 1907). *E. spathulata*. **j**, adult leaf; **k**, buds; **l**, fruits (all from *Hill 328, Johnson & Blaxell*). Scale bar = 1 cm.

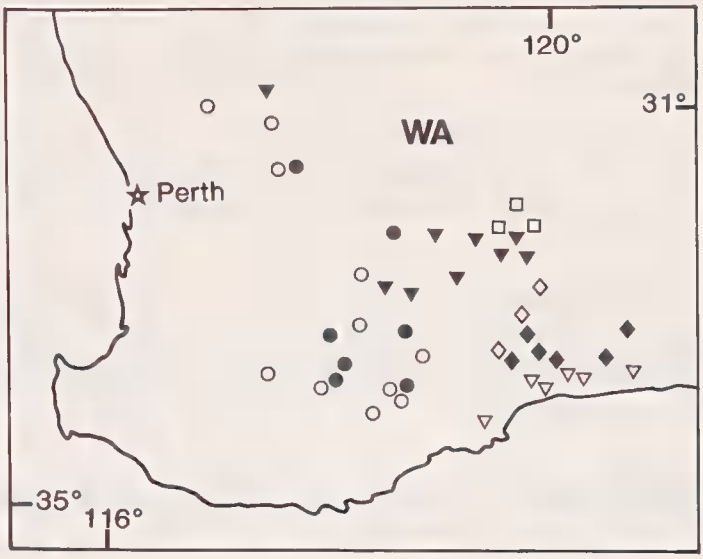

Figure 9. Distribution of *E. spathulata* (●), *E. vegrandis* (○), *E. suggrandis* subsp. *suggrandis* (▽), subsp. *alipes* (▼), subsp. *alipes* – subsp. *suggrandis* intergrades (◆), *E. steedmanii* (□) and *E. goniocarpa* (◇).

Mallee to 6 m, often less. *Bark* smooth, semiglossy, grey to brown or bronze. *Juvenile leaves* disjunct, linear to narrow-lanceolate. *Adult leaves* disjunct, linear to lanceolate, glossy, with a distinct bluish sheen from the large translucent stomata, 3–8 cm long, 3–8 mm wide; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 3- or 7-flowered; peduncles 5–15 mm long; pedicels 2–4 mm long. *Buds* cylindrical, 8–12 mm long, 3–5 mm diam.; calyptra slightly longer to almost 2 times longer than hypanthium, cylindrical, apically rounded. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical or hemispherical, 5–8 mm long, 5–8 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. Figure 8.

Differs from *E. spathulata* in the mallee habit, shorter and broader leaves, shorter calyptra and larger fruits. This taxon has a considerably wider range than *E. spathulata*, although the two are sympatric in the south of the range of *E. vegrandis*. Where the two are sympatric, *E. spathulata* occurs on low saline sites while *E. vegrandis* occurs on higher, sandy sites.

There is some breakdown between the two taxa in areas where both occur. Both species and some intergrades in the contact zones can be observed on the Pingrup road N of Ongerup, as was pointed out to us in the field by the late Ken Newbey. Occasional hybrids with *E. xanthonema* Turcz., i.e. *E. xanthonema* subsp. *xanthonema* as recognised by Brooker & Hopper (1991), are also recorded.

In the northernmost part of its area (north of c. 31°15'S), *E. vegrandis* has 3-flowered umbellasters (mostly 7-flowered in the south) and the fruits are larger than is general in the south.

DISTRIBUTION: Scattered and sporadic, from Wongan Hills south to Arthur River and southeast to Ongerup (Avon and Roe Districts). Figure 9.

ECOLOGY: Usually on moderately well-drained sandy loams, but often not far from somewhat saline areas.

CONSERVATION STATUS: Not considered to be at risk.

The epithet is from the Latin *vegrandis*, not very large, referring both to its small stature and because it has been confused with *E. suggrandis* under the name *E. spathulata* var. *grandiflora*.

SELECTED SPECIMENS (from 14 examined): WESTERN AUSTRALIA (W to E): c. 12 km E of rail crossing at Carani, *Brooker 7584*, 26 Aug 1982 (CANB, NSW, PERTH); 0.9 km from Dowerin–Trayning road on Minnievale Road, *Brooker 9748*, 3 Sep 1987 (CANB, NSW, PERTH); Cunderdin,*Fitzgerald*, Nov 1907 (NSW); Carganocking Hill, *Hill 654, Johnson, Blaxell, Brooker & Hopper*, 8 Nov 1983 (NSW, CANB, PERTH); Broome Hill, *Morrison*, 16 Apr 1904 (NSW); 6 km N of Borden, *Crisp 5174*, 15 Jan 1979 (CBG, CANB, NSW, PERTH).

***E. spathulata* – *E. vegrandis* intergrades:** cited under the former.

***E. loxophleba* subsp. *loxophleba* x *E. vegrandis*:** specimens cited under the former.

***E. vegrandis* x *E. xanthonema*:** 24 miles [38 km] S of Williams, *Melville 4358 & Royce*, 28 Aug 1953 (K, NSW)

9. Eucalyptus suggrandis *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. spathulata* habitu multicauli plusminusve fruticoso, ab illa et ab *E. vegrandi* et *E. spathulata* alabastris fructibusque majoribus distinguitur.

TYPE: WESTERN AUSTRALIA: Hamersley Drive, 32.5 km from Old Ongerup Road, Fitzgerald River National Park, *K.D. Hill 3147*, 7 Sep 1988 (holo NSW; iso CANB).

≡ *Eucalyptus spathulata* Hook. var. *grandiflora* Benth., Fl. Austral. 3: 236 (1867).

TYPE CITATION: 'Phillips Range, Maxwell.'

TYPE: WESTERN AUSTRALIA: Phillips Range, *Maxwell* (holo K; iso NSW).

≡ *E. spathulata* Hook. subsp. *grandiflora* (Benth.) L. Johnson & Blaxell, Contrib. New South Wales Natl Herb. 4(7): 453 (1973).

Although this taxon includes a previously published variety (and subspecies), we have chosen to publish it as a new species with a new type from a known locality. This is preferred because the old concept of *E. spathulata* is now divided into four taxa, and where possible we have nominated types from known and studied populations.

Mallee to 4 m. *Bark* smooth, semiglossy, grey to light brown or bronze. Juvenile leaves disjunct, narrow-lanceolate. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, glossy, with a distinct bluish sheen from the large, translucent stomata, 4–8 cm long, 5–15 mm wide; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 3–7-flowered; peduncles flattened, 8–15 mm long; pedicels flattened, 3–8 mm long. *Buds* often 2-winged, ovoid to shortly fusiform, 11–17 mm long, 5–7 mm diam.; calyptra slightly longer to 1.5 times longer than hypanthium, shortly cylindrical or convex-conical, apically rounded, smooth or finely verrucose. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical, 8–12 mm long, 6–9 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. Figure 8.

This taxon differs from *E. spathulata* and *E. vegrandis* in the larger buds with shorter calyptra, the larger fruits, and the broader leaves.

The epithet is from the Latin *suggrandis*, rather large, referring to the size of buds and fruits in comparison with *E. spathulata* and *E. vegrandis*.

Two subspecies, showing considerable intergradation where their ranges meet, are recognised on the basis of regional variation in leaf shape, bud number and ornamentation, and pedicel length.

1 Pedicel less than 4 mm long, umbellasters 3–7-flowered .... **9a.** subsp. **suggrandis**

1* Pedicel more than 4 mm long, umbellasters consistently 3-flowered ..... **9b.** subsp. **alipes**

9a. Eucalyptus suggrandis *L. Johnson & K. Hill* subsp. **suggrandis**

Mallee. *Adult leaves* lanceolate to broad-lanceolate. *Umbellasters* 3–7-flowered. *Peduncle* 8–12 mm long, not strongly flattened. *Pedicels* 3–5 mm long, ribbed but not strongly winged. *Buds* 11–15 mm long, 5–6 mm diam, calyptra smooth or finely verrucose. *Fruits* 8–11 mm long, 8–9 mm diam. Figure 8.

Distinguished by the short pedicels and often 7-flowered umbellasters. In mature buds the calyptra is generally more warty than in subsp. *alipes*. The characters of the subspecies are most marked in the southernmost parts of the range.

Distribution: Locally frequent, from the Gairdner River to the Young River, south of about 33°35'S (Eyre District). Figure 9.

Ecology: A component of mixed mallee heath on various low-nutrient substrates.

Hybrids are recorded with *E. platypus* Hook. and *E.* species F (Brooker & Kleinig 1988).

Conservation status: Not considered to be at risk.

Selected specimens (from 19 examined): Western Australia (W to E): c. 10 km S of Ravensthorpe on Hopetoun road, *Blaxell 1697*, 23 June 1978 (NSW); Eldverton via Ravensthorpe, *Brooker 8659*, 4 Sep 1984 (CANB, NSW, PERTH); E slope of Mt Desmond, *B. Briggs 7716 & Johnson*, 10 Oct 1984 (NSW, PERTH); 4.5 km S of highway on Mason Bay road, *Hill 2359, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW); 14.1 km S of Old Ongerup Road on Hamersley Drive, Fitzgerald River Natl Park, *B. Briggs 7685, 7686, 7687 & Johnson*, 9 Oct 1984 (NSW, PERTH); 10.0 km NW of Fitzgerald River Natl Park entrance on Devils Creek Road, *Hill 3111, 3112*, 6 Sep 1988 (NSW, CANB, PERTH); NW of Mt Maxwell, *Brooker 9910, 9911*, 9 Mar 1988 (CANB, NSW).

Intergrades between the subspecies (8 examined): 44 km N of Ravensthorpe – Albany road on Lake King road, *Hill 2381, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW, PERTH); 11.7 km from Ravensthorpe–Lake King road on Aerodrome Road, *Hill 3023*, 1 Sep 1988 (NSW); 13.5 km from highway on Fitzgerald Road (33°25'S 119°45'E), *Brooker 8808*, 18 Jan 1985 (CANB, NSW, PERTH); 55 km W of Fields Road (5 ways) on Ravensthorpe track, *Hill 2343, Johnson & Blaxell*, 8 Nov 1986 (NSW, PERTH); Ravensthorpe, *Ralph & Stamford*, 26 June 1924 (NSW).

***E. suggrandis* subsp. *suggrandis* x *E.* species F:** 15.6 km from Highway 1 along Brook Road (33°49'S 119°05'E), *Brooker 9641*, 18 May 1987 (CANB, NSW, PERTH).

9b. Eucalyptus suggrandis *L. Johnson & K. Hill* subsp. **alipes** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica pedicellis longis aliquanto alatis et umbellastris semper trifloris differt.

Type: Western Australia: 46.0 km N of Coolgardie – Hyden road on Southern Cross road, *K.D. Hill 2894*, 26 Aug 1988 (holo NSW; iso CANB, PERTH).

Mallee. *Adult leaves* narrow-lanceolate to lanceolate. *Umbellasters* 3-flowered. Peduncle strongly flattened, 10–15 mm long. *Pedicels* 2-winged, 4–8 mm long. *Hypanthium* 2-winged;

calyptra smooth. *Fruits* 8–12 mm long, 6–8 mm diam. Figure 8.

Distinguished by the long, winged pedicels and always 3-flowered umbellasters. The related taxa *E. goniocarpa* and *E. steedmanii* are also 3-flowered, but have substantially larger buds and fruits (see below).

Distribution: This subspecies ranges from Lake Grace to east of Hyden and midway between Lake King and Ravensthorpe (Roe and Eyre Districts). Figure 9.

Ecology: A frequent component of mallee heath on sandy loam or sandplain, usually in low mixed mallee communities.

Hybrids are recorded with *E. depauperata*.

Conservation status: Not considered to be at risk.

The epithet is from the Latin *ala*, a wing, and *pes*, a foot, referring to the pedicels. It does not change with gender of the generic name and is pronounced as three syllables with the stress on the first.

Selected specimens (from 11 examined): Western Australia (W to E): 0.95 miles [1.5 km] E of Manmanning, *Smith 1158*, 11 Mar 1989 (MEL, AD, BRI, CANB, NSW, PERTH); 31.8 km W of Hyden towards Kondinin, *Hill 643, Johnson, Blaxell, Brooker & Hopper*, 8 Nov 1983 (NSW, CANB, PERTH); 4.2 km S of Varley road on Dragon Rock road, *Hill 2470, Johnson & Blaxell*, 14 Nov 1986 (NSW, PERTH); 43 km E of Hyden, *Blaxell W75/26 & Brooker*, 3 Oct 1975 (NSW); 46.0 km N of Coolgardie–Hyden road on Southern Cross road, *Hill 2894*, 26 Aug 1988 (NSW, CANB, PERTH); 13 miles [22 km] NE of Lake Grace, *M.I.H. Brooker 2271*, 5 June 1969 (CANB, NSW, PERTH).

***E. suggrandis* subsp. *alipes* – subsp. *suggrandis* intergrades x *E. vegrandis*:** Facup Creek, *Diels 4767*, 8 Oct 1901 (B, NSW).

***E. depauperata* x *E. suggrandis* subsp. *alipes*:** cited under *E. depauperata*.

***E. platypus* x *E. suggrandis* subsp. *alipes*:** 10 km from Lake King towards Newdegate, *Strid 21964*, 1 Jan 1983 (NSW).

10. Eucalyptus goniocarpa *L. Johnson & K. Hill*, **sp. nov.**

Ab *E. eremophila* umbellastris saepissime trifloris et alabastris fructibusque bialatis differt. Ab *E. suggrandi* subsp. *alipede* foliis alabastris et fructibus plerumque majoribus differt.

Type: Western Australia: 5.6 km from Lake King on Ravensthorpe road, *K.D. Hill 2383, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 9 Nov 1986 (holo NSW; iso PERTH).

Tree (mallet) to 5 m, sometimes mallee to 4 m. *Bark* smooth, semiglossy, grey to brown or bronze. *Juvenile leaves* disjunct, lanceolate. *Adult leaves* disjunct, lanceolate, glossy, with a distinct bluish sheen from the large, translucent stomata, 4–8 cm long, 5–10 mm wide; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 3(–7)-flowered; peduncles flattened, 8–15 mm long; pedicels flattened, 3–8 mm long. *Buds* distinctly 2-winged, ovoid to shortly fusiform, 11–17 mm long, 5–7 mm diam.; calyptra slightly longer to 2 times as long as hypanthium, shortly cylindrical or convex-conical, apically rounded. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* 2-winged, ovoid to obconical, 8–12 mm long, 6–9 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. *Seeds* ovoid, somewhat flattened, grey-brown, regularly shallowly reticulate. Figure 10.

Distinguished from *E. eremophila* by the mostly 3-flowered umbellasters and the 2-winged buds and fruits. This taxon shows some resemblances to *E. suggrandis* subsp. *alipes*, from which it differs in the larger leaves, buds and fruits. *E. steedmanii* is also 3-flowered, but has strikingly quadrangular buds and fruits.

Figure 10. *E. goniocarpa*. **a**, adult leaves and buds; **b**, fruits (all from *Hill 2383, Johnson, Blaxell & Brooker*). *E. eremophila*. **c**, adult leaves and buds; **d**, fruits (all from *Hill 219 & Johnson*). *E. tenera*. **e**, adult leaves and buds; **f**, fruits (all from *Hill 2480 & Johnson*). Scale bar = 1 cm.

This taxon has been referred to *E. eremophila* subsp. *pterocarpa* (Blakely & Steedman) L. Johnson & Blaxell (Brooker & Kleinig 1990: 146). The latter is, however, said to occur in rocky sites, with no mention of the 'mallet' habit. This represents another possibly distinct species related to *E. eremophila*, and has not been rediscovered to date. It is distinguished by the larger fruits on longer pedicels, and the entire adult leaves.

Distribution: Restricted to the Lake King district (Roe District). Figure 9.

Ecology: This species forms dense, often monospecific, thickets on sandy loams on flat or slightly low areas.

Extensive intergrades occur with *E. platypus* Hook., forming dense low mallet stands in country west and northwest of Ravensthorpe (these are treated as *E. platypus* subsp. *congregata* ined. by Brooker & Kleinig 1990).

Conservation status: Not considered to be at risk.

The epithet is from the Greek *gonia*, an angle, and *karpos*, a fruit, referring to the strongly angled fruits.

Selected specimens (from 6 examined): Western Australia (N to S): 4.7 km from Lake King–Norseman road on Pickernill Road, *Brooker 8766*, 18 Dec 1984 (CANB, NSW, PERTH); 17.6 km E of Tarco Road (33°14'S 119°33'E), *Brooker 9716*, 15 July 1987 (CANB, NSW, PERTH); 9 km SW of Koornong Road on Fitzgerald Road, *Foreman 1339*, 29 Nov 1985 (MEL, CANB, NSW, PERTH).

Intergrades with *E. platypus* (from 3 examined): 5.8 km NW of Fitzgerald Road on West River Road, *Hill 2397, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW).

11. Eucalyptus eremophila (Diels) Maiden, J. & Proc. Roy. Soc. New South Wales 54: 71 (1920).

Basionym: *Eucalyptus occidentalis* Endl. var. *eremophila* Diels in Diels & Pritzel, Bot. Jahrb. Syst. 35: 442 (1904).

Type citation: 'Hab. in distr. Coolgardie pr. Boorabbin in glareosis fl. m. Nov. (E. Pritzel Pl. Austr. occ. 917), pr. munic. Coolgardie in fruticetis apertis arenoso-lutosis flor. m. Oct. (D. 5237), in fruticetis apertis lutoso-lapidosis fl. m. Nov. pr. Gilmores (D. 5264).'

Type: Western Australia: near Coolgardie, *L. Diels 5237* (lecto NSW, here designated). Diels cited 3 syntypes in the protologue, but Maiden recorded the above as the Type for Diels's variety (Crit. Revis. Eucalyptus 4: 176, pl. 149, Figure 7). This specimen is hence here designated as the lectotype.

Tree (mallet) to 12 m or mallee to 6 m. *Bark* smooth, semiglossy, pale grey or silver to pale brown, yellow-brown or greenish. *Juvenile leaves* disjunct, broad-lanceolate to ovate, dull, grey, petiolate. *Adult leaves* disjunct, lanceolate, glossy, with a distinct bluish sheen from the large, translucent stomata, 4–12 cm long, 5–17 mm wide; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles flattened, 15–30 mm long, to 6 mm wide; pedicels 4–8 mm long. *Buds* cylindrical, 20–30 mm long, 5–7 mm diam.; calyptra 2.5 or more times longer than hypanthium, cylindrical, apically rounded or acuminate. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical, 8–13 mm long, 7–11 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. *Seeds* ovoid, somewhat flattened, grey-brown, regularly shallowly reticulate. Figure 10.

E. eremophila is described here under a reduced circumscription to allow comparison with segregate taxa described below.

DISTRIBUTION: Though here restricted from its most inclusive usage, this is a widespread and frequent species, extending from the Southern Wheat Belt (as far west as Lake Chinokup) through the southern and central Goldfields to the edges of the Nullarbor Plain and Great Victoria Desert. It is replaced in adjoining areas by one or other of the following three species or more locally by the partly sympatric *E. incerata* Brooker & Hopper ined. Figure 11.

ECOLOGY: *E. eremophila* shows a wide ecological tolerance, but is absent from the lightest and heaviest soils. It tends to occur as trees of mallet form in woodlands on heavier or more calcareous soils, and as mallees in mallee shrublands on sandier soils.

Hybrids are recorded with *E. grossa* F. Muell. ex Benth. and (in cultivation) *E. torquata* Luehm. The latter is an intersectional hybrid with a member of sect. *Dumaria*.

CONSERVATION STATUS: Widespread and abundant, not considered to be at risk.

SELECTED SPECIMENS (from 48 examined): WESTERN AUSTRALIA: 1 km SW of S shore of Lake Chinokup, *Hill 2462, Johnson & Blaxell*, 13 Nov 1986 (NSW, PERTH); corner of Ardler Road and Old Ravensthorpe Road, *L. Johnson 9082 & M. Johnson*, 15 May 1988 (NSW, PERTH); 7.2 miles [11.5 km] E of Southern Cross, *Chippendale 98*, 7 Mar 1967 (CANB, NSW); Mt Short, 10 miles [16 km] N of Ravensthorpe, *Wrigley*, 5 Nov 1968 (CBG 030980, NSW); 33.1 km W of Coolgardie – Norseman road on Hyden track, *Hill 605, Johnson, Blaxell, Brooker & Hopper*, 7 Nov 1983 (NSW); 30.8 km W of highway on Griggs Road, *Hill 2305, Johnson & Blaxell*, 7 Nov 1986 (NSW, PERTH); 52.1 km S of Norseman on highway, *Hill 2234, Johnson, Blaxell & Brooker*, 5 Nov 1986 (NSW, PERTH); 109 km W of Balladonia on Norseman road, *Brooker 6457*, 22 Aug 1979 (CANB, NSW, PERTH); 22.5 km W of Balladonia Roadhouse on Highway 1, *Hill 219 & Johnson*, 19 Oct 1983 (NSW); 8.6 km S of Queen Victoria Spring on Cundeelee track, *Hill 2682 & Johnson*, 30 Nov 1986 (NSW); 13 miles [21 km] E of Zanthus, *Brooker 2573*, 18 June 1970 (PERTH, NSW).

***E. eremophila* x *E. grossa*:** 23.6 km W of highway on Lake King road, *Brooker 8844*, 12 Feb 1985 (CANB, NSW, PERTH).

***E. eremophila* x *E. torquata*:** Cult. Oaklands, N.S.W., *O'Rourke*, July 1971 (NSW).

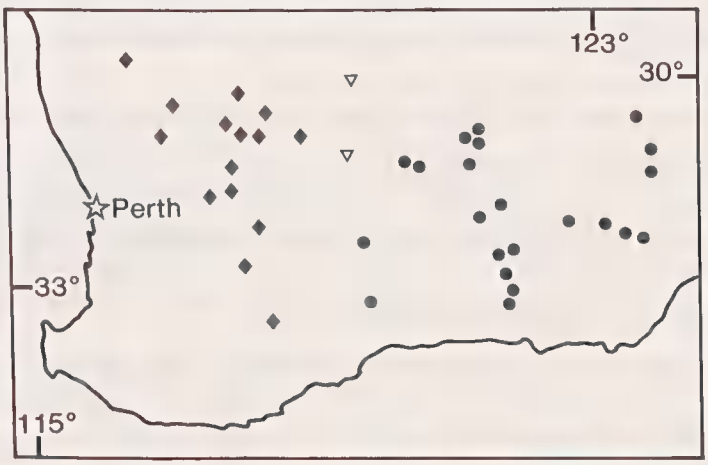

Figure 11. Distribution of *E. eremophila* (●), *E. tenera* (◆) and intergrades between the two (▽).

12. Eucalyptus tenera *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. eremophilae* sed characteribus sequentibus distinguitur: habitus et partes multi minores, umbellastrae saepissime 11-florae, pedunculi breviores gracilioresque, calyptra proportione longior acutiorque.

Type: Western Australia: Bencubbin, *M.I.H. Brooker 8493*, 16 Mar 1984 (holo NSW; iso AD, CANB, MEL, PERTH).

Mallee to 4 m. *Bark* smooth, semiglossy, pale grey or grey to red-brown or bronze. *Juvenile leaves* disjunct, linear for first 3–4 nodes, then becoming lanceolate. *Adult leaves* disjunct, lanceolate to broad-lanceolate, glossy, with a distinct bluish sheen from the large, translucent stomata, 4–8 cm long, 7–18 mm wide; petioles 10–14 mm long; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 7–11-flowered; peduncles narrowly flattened, 18–25 mm long, to 5 mm wide; pedicels 3–6 mm long. *Buds* cylindrical, 25–40 mm long, 5–7 mm diam.; calyptra 3 times or more longer than hypanthium, cylindrical, apiculate. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing by parallel slits. *Fruits* ovoid to obconical, 8–11 mm long, 7–10 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. *Seeds* ovoid, somewhat flattened, grey-brown, regularly shallowly reticulate. Figure 10.

E. tenera is distinguished from *E. eremophila* by the generally smaller form and smaller parts, the frequently 11-flowered umbellasters (always 7-flowered in the latter), the shorter, thinner and narrower peduncles, and the longer buds with a relatively longer and more acute calyptra.

Distribution: Sporadically distributed over a wide area of the western and northern Wheat Belt, from Coorow to Chiddarcooping Rock, south towards Lake Chinokup. Figure 11.

Ecology: Restricted to shallower, sandy soils with various other mallee species in areas where wandoo woodlands occupy the deeper soils.

Hybrids are recorded with *E. erythronema* sens. lat.

Conservation status: Not considered to be at immediate risk. The habitat of this species lies entirely within the Wheat Belt agricultural country, and continued degradation of that area may place the entire habitat at risk in the future.

The epithet is from the Latin *tener*, delicate, referring to the species having smaller and more slender parts than those of *E. eremophila* and *E. tephroclada*.

Selected specimens (from 17 examined): Western Australia (N to S): 'Doley's Farm', ESE of Coorow, *Brooker 9059*, 3 Nov 1985 (CANB, NSW, PERTH); 33.8 km S of Koorda on Wyalkatchem road, *Hill 2918*, 27 Aug 1988 (NSW); 28.3 km from Tammin on York road, *Brooker 9105*, 15 Nov 1985 (CANB, NSW PERTH); 9 km N of Scotsmans Road on Bimbijy Road, *Brooker 8435*, 25 Jan 1984 (CANB, NSW, PERTH); 2.0 km E of Dickinson Road on Nambadilling Road, *Hill 2480, Johnson & Blaxell*, 15 Nov 1986 (NSW, CANB, CBG, MEL, PERTH); Chiddarcooping Nature Reserve, *Brooker 7980*, 11 Feb 1983 (CANB, NSW, PERTH).

***E. erythronema* sens. lat. x *E. tenera*:** Kellerberrin, *Vachel*, Dec 1903 (NSW); 'Oxendale' farm, Barnes Road, SE of Yelbeni, *Brooker 9735*, 23 July 1987 (CANB, NSW, PERTH).

13. Eucalyptus tephroclada *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. eremophilae* combinatione characterum sequentium distinguitur: ramuli pruinosi, fructus parvi.

TYPE: WESTERN AUSTRALIA: 6 km from Bruce Rock on Narembeen road, *K.D. Hill 2484*, *L.A.S. Johnson & D.F. Blaxell*, 15 Nov 1986 (holo NSW; iso PERTH).

[*Eucalyptus erythronema* Turcz. var. *roei* Beck ex Maiden, Crit. Revis. Eucalyptus 1: 110 (1904); in syn., nom. nud.; in part]

Mallee to 5 m. *Bark* smooth, semiglossy, dark grey to red-brown or bronze. Branchlets pruinose. *Juvenile leaves* disjunct, lanceolate to broad-lanceolate, dull, grey, petiolate. *Adult leaves* disjunct, lanceolate, glossy, with a distinct bluish sheen from the large, translucent stomata, 4–10 cm long, 7–19 mm wide; pedicels flattened, 6–16 mm long; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. *Inflorescences* simple, axillary; umbellasters 7–11-flowered; peduncles terete or narrowly flattened; 17–30 mm long, to 3 mm wide; pedicels 4–10 mm long. *Buds* cylindrical, 18–35 mm long, 5–7 mm diam.; calyptra 2.5 or more times longer than hypanthium, cylindrical, apically rounded. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical, 8–11 mm long, 7–10 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. *Seeds* ovoid, somewhat flattened, grey-brown, regularly shallowly reticulate. Figure 12.

Distinguished within the *E. eremophila* group by the pruinose branchlets and the small fruits. The related *E. incerata* Brooker & Hopper ined. (another member of the *E. eremophila* group) shares the bronze or coppery bark and glaucous branchlets, but has larger buds and fruits (buds 6–8 mm diam., fruits 10–14 mm long), and tends to be heavily rather than lightly pruinose. The two taxa also show a replacement distribution.

DISTRIBUTION: Sporadic and scattered in the area between Quairading, Southern Cross, Kukerin and Hyden (Avon and Roe Districts). This is now all largely cleared agricultural country. Figure 13.

ECOLOGY: Restricted to local mallee scrubs on usually shallow and sandy soils, over various substrates in otherwise woodland country.

Hybrids are recorded with *E. cylindriflora* Maiden & Blakely and *E. erythronema*.

CONSERVATION STATUS: 3V?C. The habitat has been seriously reduced by agricultural clearing.

The epithet is from the Greek *tephros*, ash-grey, and *klados*, a twig, referring to the pruinose branchlets.

SELECTED SPECIMENS (from 19 examined): WESTERN AUSTRALIA (N to S): c. 5 miles [8 km] E of Bodallin, *Johnson W 130*, 16 Dec 1960 (NSW); 3 km W of Hyden, *Strid 21940*, 31 Dec 1982 (NSW); 6 km NW of Jitarning, *Foreman 1139*, 21 Nov 1985 (MEL, AD, CANB, NSW, PERTH); Harrismith, *Gardner 2118*, 6 Mar 1924 (PERTH, NSW).

***E. cylindriflora* x *E. tephroclada*:** 22 km SE of Pingaring, *Haegi 1083*, 21 Sep 1976 (AD, NSW, PERTH).

***E. erythronema* x *E. tephroclada*:** Noongar, *Chippendale 286*, 13 Aug 1967 (CANB, NSW).

14. Eucalyptus depauperata *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. eremophilae* combinatione sequenti characterum distinguitur: habitus pluricaulis et fruticosus; folia adulta, alabastra et fructus minores.

TYPE: WESTERN AUSTRALIA: 1.6 km N of Hayes Road on North Road, *K.D. Hill 3027*, 1 Aug 1988 (holo NSW; iso CANB, PERTH).

[*Eucalyptus* sp. E of Brooker & Kleinig (1990)]

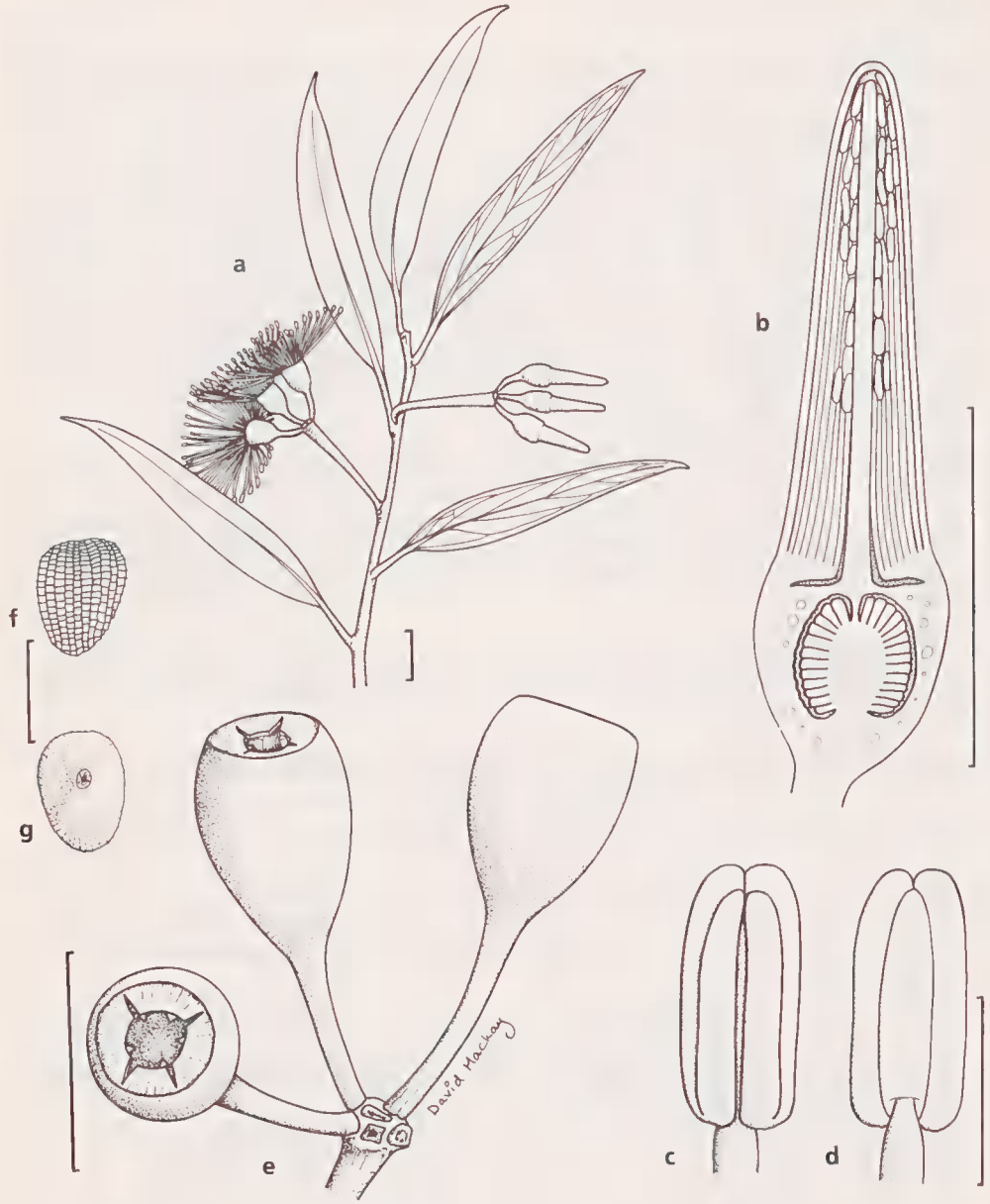

Figure 12. *E. tephroclada*. **a**, adult leaves, flowers and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (all from *Strid 21940*). Scale bar: a, b, e = 1 cm; c, d, f, g = 1 mm.

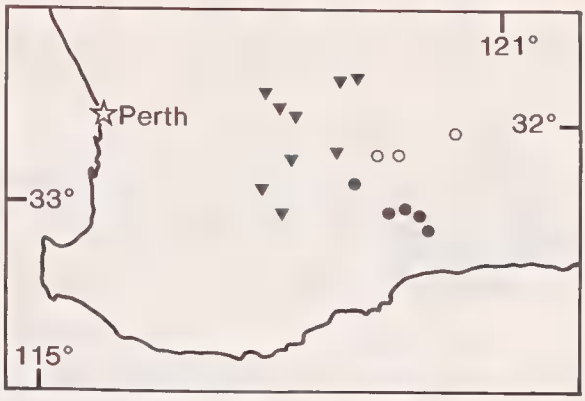

Figure 13. Distribution of *E. tephroclada* (▼), *E. incerata* (○) and *E. depauperata* (●).

Mallee to 4 m. *Bark* smooth, semiglossy, pale grey or silver to pale brown. *Juvenile leaves* disjunct, lanceolate. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, glossy, often with a distinct bluish sheen from the large, translucent stomata, 3–7 cm long, 5–12 mm wide; petioles 8–11 mm long; lateral veins scattered; reticulation sparse, incomplete; oil glands crowded, spherical. Inflorescences simple, axillary; umbellasters 7-flowered; peduncles 8–25 mm long; pedicels 3–5 mm long. *Buds* cylindrical, 16–21 mm long, 5–6 mm diam.; calyptra 2.5 times or more longer than hypanthium, cylindrical, apically rounded. *Stamens* all fertile; filaments erect; anthers oblong, dorsifixed, dehiscing through parallel slits. *Fruits* ovoid to obconical, 8–10 mm long, 6–8 mm diam.; stemonophore broad, flat, persistent; disc flat; valves acicular, basally enclosed, apically exserted. *Seeds* ovoid, somewhat flattened, grey-brown, regularly shallowly reticulate. Figure 14.

Distinguished within the *E. eremophila* group by the small leaves, buds and fruits. It is also usually a small, slender 'whipstick' mallee in contrast to the more robust habit of other members of the *E. eremophila* complex.

Distribution: Locally frequent in the area around Lake King, extending northwest towards Pingaring (Roe District). Figure 13.

Ecology: Occurs in mixed mallee shrublands, on lateritic sand or sandy loam.

Hybrids are recorded with *E. grossa* F. Muell. ex Benth. and *E. suggrandis* subsp. *alipes*.

Conservation status: 2R. Substantial populations occur in relatively undeveloped country. Future development could, however, threaten this species.

The epithet is from the mediaeval Latin *depauperatus*, made poor, referring to the generally smaller parts and lower stature than those of *E. eremophila* and its other close allies.

Selected specimens (from 7 examined): Western Australia (W to E): 4.2 km S of Varley Road on track to Dragon Rock, *Hill 2469, Johnson & Blaxell*, 14 Nov 1986 (NSW, PERTH); 52 km N of Ravensthorpe on Hatters Hill Road, *Hill 319, Johnson & Blaxell*, 22 Oct 1983 (NSW); 13.6 km S of Lake King–Norseman road on Hatters Hill Road, *Brooker 8177*, 7 June 1983 (CANB, NSW, PERTH); 4.5 km W of rabbit-proof fence east of Lake King, *Brooker 8848*, 12 Feb 1985 (CANB, NSW, PERTH).

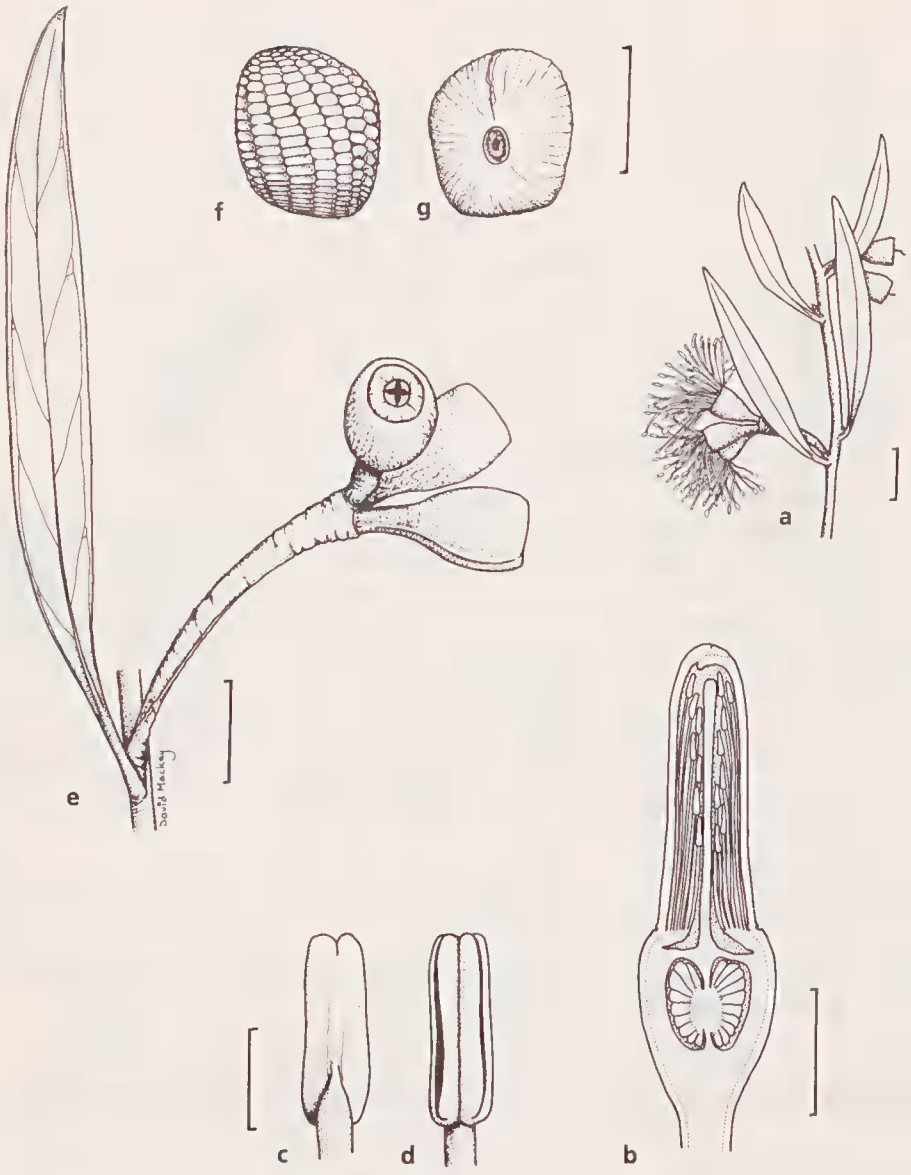

Figure 14. *E. depauperata*. **a**, adult leaves and flowers; **b**, section of bud; **c**, **d**, anther; **e**, adult leaf and fruits; **f**, **g**, seed (**a**, **c**, **d**, **e**, **f**, **g** from *Hill 319, Johnson & Blaxell*, **b** from *Brooker 8177*). Scale bar: a, e = 1 cm; b = 5 mm; c, d, f, g = 1 mm.

***E. depauperata* x *E. grossa*:** 17.7 km W of Lake King, *Hill 2391, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW).

***E. depauperata* x *E. suggrandis* subsp. *alipes*:** 13.6 km S of Lake King–Norseman road on Hatters Hill Road, *Brooker 8177*, 7 June 1983 (CANB, NSW, PERTH).

Series *Cneorifoliae*

Species 15 to 19 are placed in series *Cneorifoliae*, defined by the combination: pith glands absent; filaments inflexed or irregularly flexed; anthers globoid to reniform, basifixed, subversatile, dehiscing by broad, angled slits; seeds shallowly reticulately pitted, dorsiventrally compressed.

15. Eucalyptus phylacis *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. decipienti* sed inter affinitatem illae combinatione sequenti characterum distinguitur: folia lanceolata; alabastra mediocria, ovoidea et non constricta; calyptra hypanthium aequans, conica; stylus brevis, rectus; fructus breviter pedicellati; pedunculus longus.

Type: Western Australia: Meelup, east side of Cape Naturaliste (33°35'S, 115°01'E), *D.F. Blaxell 2000, L.A.S. Johnson & M.I.H. Brooker*, 31 May 1983 (holo NSW; iso CANB, K, PERTH).

[*Eucalyptus* sp. K of Brooker & Kleinig (1990)]

Tree to 5 m. *Bark* persistent on trunk and large branches, rough, coarsely flaky, light grey-brown; outer branches smooth. *Juvenile leaves* disjunct, blue-grey, ovate to orbicular, to 5 cm long, 4 cm wide. *Adult leaves* disjunct, lanceolate to broad lanceolate, acute or acuminate, falcate, dull, 6–13 cm long, 11–30 mm wide; petioles channelled above, 7–16 mm long; lateral veins at 30–45° to midrib, ± closely spaced, regular, densely reticulate between; intramarginal vein distinct, 0.5–1.5 mm from margin. *Umbellasters* axillary, 7–11-flowered; peduncles terete, 7–11 mm long; pedicels terete, 1–2 mm long. *Mature buds* ovoid, 8–10 mm long, 4–5 mm diam.; calyptra conical, convex, obtuse, ± as long as hypanthium. *Fruits* cup-shaped or hemispherical, 3–4-locular, 5–7 mm long, 7–9 mm diam.; calyptra scar raised, angled incurved at c. 45°, c. 0.5 mm wide; disc ± flat, convex, 1.5–2.0 mm wide (with distinctive radial cracks crossing disc, scar and hypanthium caused by subsequent internal growth of fruit); style persistent, frequently remaining attached to one valve in open fruits; valves enclosed at base, vertically exserted, triangular. Figure 15.

Distinguished within the *E. decipiens* Endl. group by the following combination of characters: Juvenile leaves obtuse to rounded (not emarginate); adult leaves lanceolate; buds medium to large (8 mm long, 5 mm diam.), ovoid, not constricted; calyptra about as long as hypanthium, conical, convex; style short, straight, tip shallowly engaged in calyptra; fruits pedicellate (pedicel 1–2 mm long); peduncle to 12 mm long. The widespread *E. decipiens* is distinguished by the emarginate juvenile leaves, and the apparently closely related rare species *E. balanites* Grayling & Brooker ined. is distinguished by the rounded calyptra which is narrower than the hypanthium, and the larger buds (to 10 mm long).

Distribution: Discovered by Dr Neville Marchant of the Western Australian Herbarium, *E. phylacis* is known only from a single population in the Cape Naturaliste area in the far south-west (Menzies District). Figure 16.

Ecology: Localised and not frequent, in a patch of mallee-heath country on undulating laterite, in an open area in otherwise *E. calophylla* Lindley – *E. marginata* Sm. woodland.

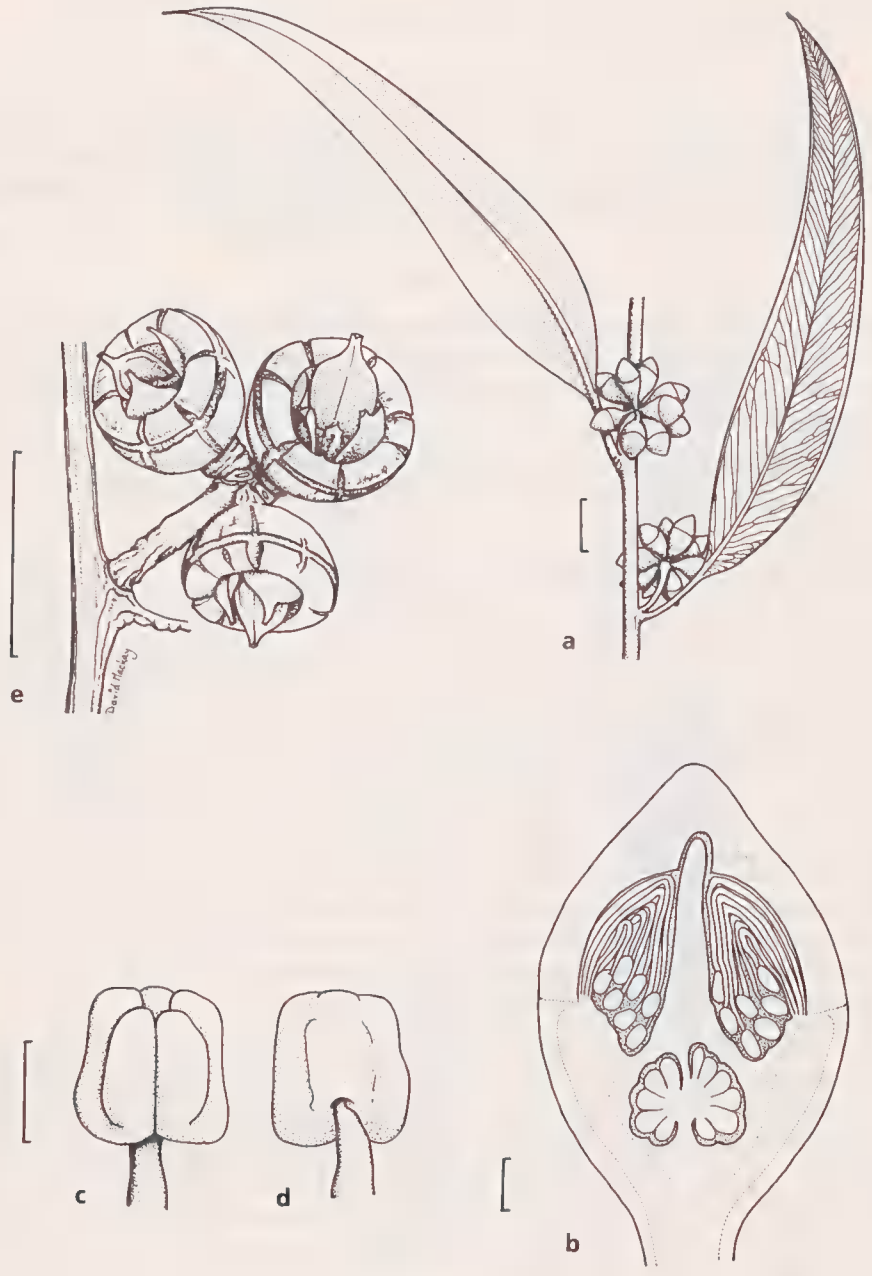

Figure 15. *E. phylacis*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits (all from *Blaxell 2000*). Scale bar: a, e = 1 cm; b = 1 mm; c, d = 0.5 mm.

CONSERVATION STATUS: 2V-. Known only from the type area, where the population has already been damaged by roadworks.

The specific epithet is from the Greek *phylakis*, a watcher or guard (female), referring to its occurrence on a hill overlooking the ocean. The feminine word (masculine equivalent *phylax*) is chosen to agree with the gender of *Eucalyptus*, but the word is a noun and not subject to change with a change of generic association. The 'y' is short as in 'lyrical', the stress is on the first syllable, and the 'c' is soft in modern usage.

SELECTED SPECIMENS (from 7 examined): WESTERN AUSTRALIA (N to S): 2 km S of Meelup, *Hill 3074 A*, 4 Sep 1988 (NSW); 0.9 km from Cape Naturaliste road on Meelup road, *Johnson 9133 & B. Briggs*, 26 Oct 1988 (NSW, CANB); hilltop 2 km S of Meelup Beach, *Marchant 84/102*, 14 Nov 1984 (PERTH, NSW).

Figure 16. Distribution of *E. phylacis* (■), *E. balanites* (□), *E. decipiens* (◆).

16. Eucalyptus misella *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. angustissimae* sed characteribus sequentibus distinguitur: folia adulta latiora, non nitida et faciebus similioribus; folia juvenilia latiora; fructus obconici in pedunculis pedicellisque longioribus crassioribusque; calyptra brevior, plus rotundata et quam hypanthio angustior.

TYPE: WESTERN AUSTRALIA: 11.9 km N of Rollands Road along Fields Road North, W of Grasspatch (33°08'S, 121°11'E), *K.D. Hill 302*, *L.A.S. Johnson & D.F. Blaxell*, 22 Oct 1983 (holo NSW; iso CANB, K, PERTH).

[*Eucalyptus* sp. L of Brooker & Kleinig (1990)]

Mallee to 2.5 m, often less. *Foliage* dense, extending to ground. *Bark* smooth throughout, dull, grey. *Seedling leaves* opposite for 5–6 nodes, linear, ± sessile. *Juvenile leaves* disjunct, lanceolate, ± sessile, to 5 mm wide. *Adult leaves* disjunct, similifacial, lanceolate to broad-lanceolate, dull, bluish, 5–9 cm long, 8–16 mm wide; petioles to 8 mm long, broad, flattened; lateral veins moderately spaced, ± regular, at 40°–50° to midrib; oil glands large, ± dense; intramarginal vein ± obscure, 0.5–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles terete, thick, 3–5 mm long, to 3 mm thick; pedicels thick, angular, 2 mm long, tapering into hypanthium. *Mature buds* ovoid, 5–7 mm long, 4–5 mm diam.; calyptra hemispherical or

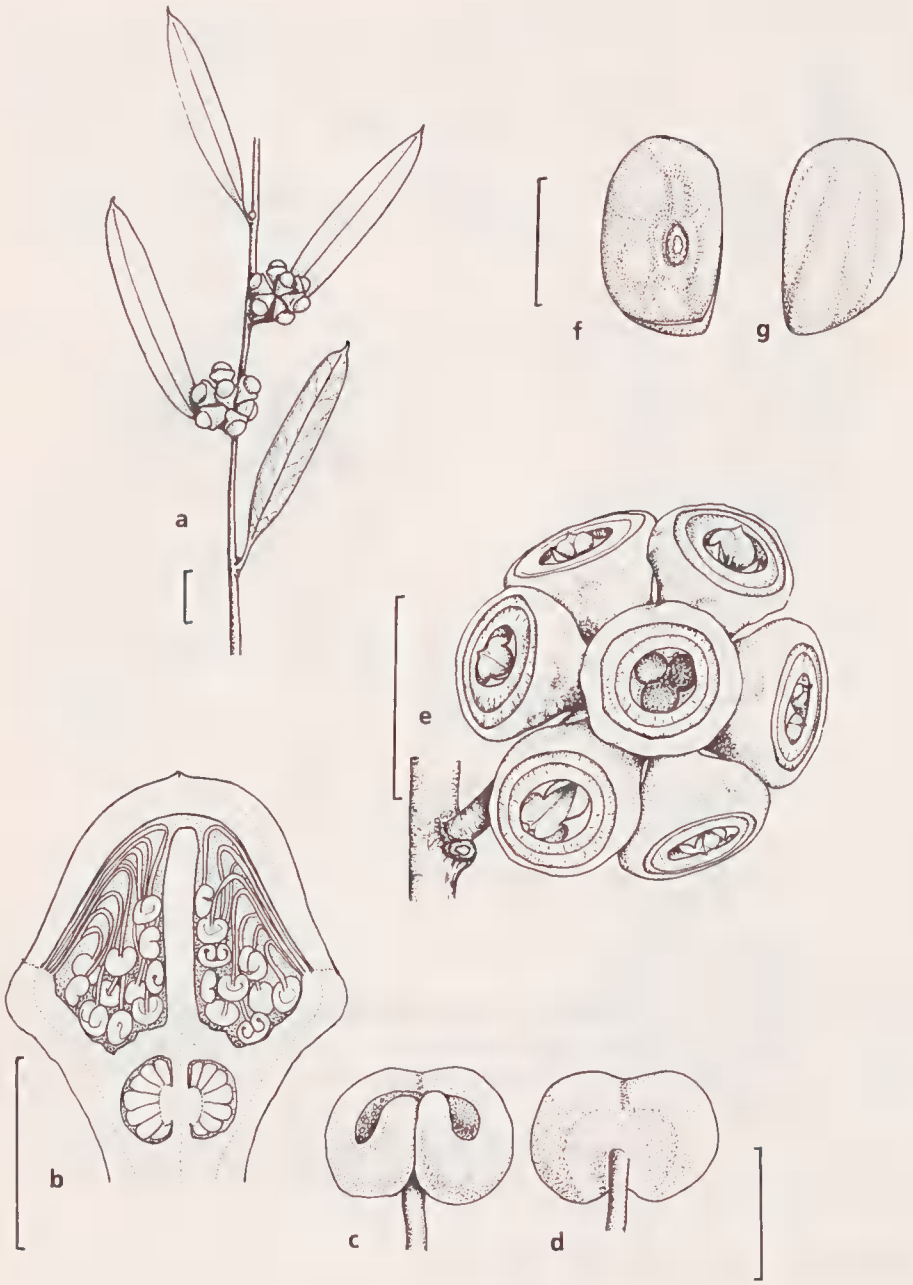

Figure 17. *E. misella*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (all from *Hill 302, Johnson & Blaxell*). Scale bar: a, e = 1 cm; b = 3 mm; f, g = 1 mm; c, d = 0.5 mm.

slightly higher, sometimes finely apiculate, about as long as hypanthium, distinctly narrower than hypanthium. *Fruits* broadly obconical to almost cup-shaped, usually 3-locular, 5–6 mm long, 6–8 mm diam.; calyptra scar flat, c. 0.2 mm wide; stemonophore expanded by tissue expansion within the hypanthium after flowering, flat, 0.5–1.0 mm wide; disc flat, 0.5–1.0 mm wide; valves broadly triangular, obtuse, apically rim level, flat, with small dorsal protuberances. *Seeds* semiglossy, pale red-brown, flattened, elliptic, regularly very shallowly reticulate (almost smooth); hilum ventral; chaff similar. Figure 17.

E. misella differs from *E. angustissima* F. Muell. in the broader, dull, more similifacial adult leaves, the broader juvenile leaves, the generally larger, obconical fruits on longer, thicker peduncles and pedicels, and the shorter, more rounded calyptra that is distinctly narrower than the hypanthium. The very similar *E. foliosa* (below) has greener, narrower leaves and slightly more delicate fruits than *E. misella*, and occurs in a quite different habitat, viz. on saline samphire flats.

Distribution: Known only from a small area west of Grasspatch in the Esperance district. Figure 18.

Ecology: Locally abundant in flat, low-lying grey or white sand-plain heath country, with *Eucalyptus tetragona* (R. Br.) F. Muell., *Eucalyptus uncinata* Turcz., *E. incrassata* Labill. (sens. lat.), *E. leptocalyx* Blakely, *E. perangusta* Brooker, *E. dolichorhyncha* (Brooker) Brooker & Hopper ined. and *E. tumida* Brooker & Hopper.

Conservation status: 2R.

The epithet is from the Latin *misellus*, wretched, in reference to the often low growth of this species.

Selected specimen (from 5 examined): Western Australia: 12.3 km N from Rollands Road on Fields Road North, *Hill 2309, Johnson & Blaxell*, 7 Nov 1986 (NSW).

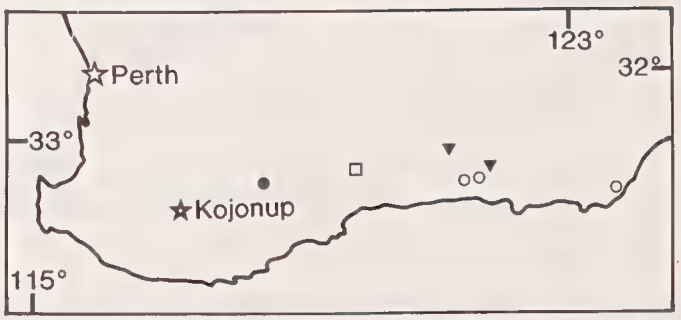

Figure 18. Distribution of *E. misella* (▼), *E. angustissima* subsp. *angustissima* (○), subsp. *quaerenda* (●) and intergrades between the two subspecies (□).

17. Eucalyptus foliosa *L. Johnson & K. Hill*, **sp. nov.**

Affinis et simillima *E. misellae* sed characteribus sequentibus et habitatione distincta distinguitur: folia adulta angustiora, virides et aliquanto nitentiores; fructus aliquanto minores in pedicellis gracilioribus; statura saepissime major.

TYPE: WESTERN AUSTRALIA: 2 km W of Norseman–Esperance road on Griffiths Road (33°29'S, 121°44'E), *K.D. Hill 2299, L.A.S. Johnson, M.I.H. Brooker & D.F. Blaxell*, 7 Nov 1986 (holo NSW; iso CANB, MEL, PERTH).

Mallee to 4 m. *Foliage* dense, extending to ground. *Bark* smooth throughout, dull, grey. Seedling leaves opposite for 5–6 nodes, linear, ± sessile. *Adult leaves* disjunct, narrow-lanceolate, green, semiglossy, 4–8 cm long, 5–10 mm wide; petioles to 10 mm long, broad, flattened; lateral veins moderately spaced, ± regular, at 30°–50° to midrib; oil glands large, ± dense; intramarginal vein ± conspicuous, 0.5–1.0 mm from margin. Inflorescences simple, axillary; umbellasters 7-flowered; peduncles terete, 2–5 mm long, to 2 mm thick; pedicels angular, 2 mm long, 1.5 mm thick, tapering into hypanthium. *Mature buds* ovoid, 5–7 mm long, 4–5 mm diam.; calyptra hemispherical or slightly longer, often broadly pointed, about as long as hypanthium, distinctly narrower than hypanthium. *Fruits* broadly obconical to almost cup-shaped, usually 3-locular, 5–6 mm long, 6–7 mm diam.; calyptra scar flat, c. 0.2 mm wide; stemonophore slightly expanded by post-flowering growth within the hypanthium, flat or slightly raised, to 0.5 mm wide; disc flat or slightly raised, 0.5–1.0 mm wide; valves broadly triangular, obtuse, apically rim level, flat, with small dorsal protuberances. *Seeds* semiglossy, pale red-brown, flattened, elliptic, regularly very shallowly reticulate (almost smooth); hilum ventral; chaff similar. Figure 19.

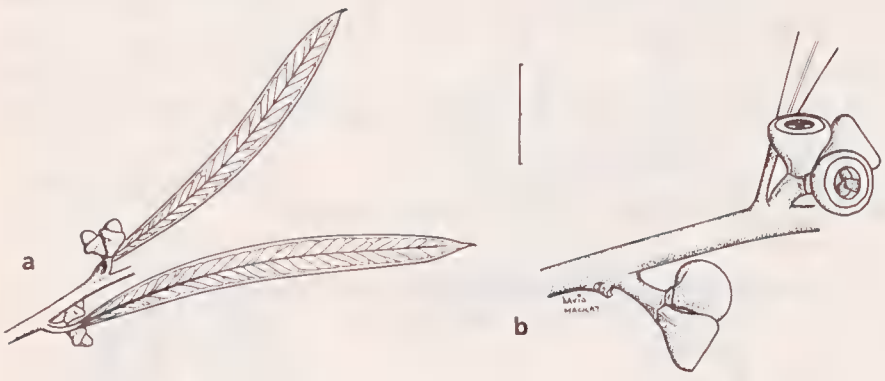

Figure 19. *E. foliosa*. **a**, adult leaves and buds; **b**, fruits (all from *Hill 2299, Johnson, Blaxell & Brooker*). Scale bar = 1 cm.

E. foliosa differs from *E. misella* in the narrower, green and somewhat glossier adult leaves, and the slightly smaller fruits on more slender peduncles. *E. foliosa* also frequently grows taller. Both taxa differ from *E. angustissima* in the broader, more similifacial leaves, the larger buds and fruits, and the distinctly constricted buds.

DISTRIBUTION: This species is known only from a small area around Scaddan and Gibson, north of Esperance.

ECOLOGY: Locally abundant on often wet and saline low-lying grey or white sandy flats adjacent to salt lakes, with *E. rigens* Brooker, *E. uncinata* Turcz., *E. halophila* D. Carr & S. Carr, and samphires.

CONSERVATION STATUS: 2R.

The epithet is from the Latin *foliosus*, leafy, referring to the dense and often deep leafy crown.

SELECTED SPECIMENS (from 6 examined): WESTERN AUSTRALIA (W to E): 2.0 km N of Gibsons Soak on highway, *Hill 2293, Johnson , Blaxell & Brooker*, 7 Nov 1986 (NSW); 6.7 km E of Highway on Scaddan Road, *Hill 2302, Johnson, Blaxell & Brooker*, 7 Nov 1986 (NSW).

18. Eucalyptus angustissima *F. Muell.*, Fragm. 4: 25 (1863).

TYPE CITATION: 'Inter promontoria Point Malcolm et Point Dover. Mxw.'

TYPE: WESTERN AUSTRALIA: between Point Malcolm and Point Dover, *G. Maxwell* (holo MEL; iso K).

Mallee to 4 m. *Bark* smooth, dull, pale grey or cream, shedding in partly adherent sheets. *Juvenile leaves* opposite, becoming disjunct, linear to narrow-lanceolate, grey. *Adult leaves* disjunct, linear to narrow-lanceolate, 4.5–13 cm long, 2–7 mm wide; petioles 2–5 mm long; lateral veins obscure; oil glands densely packed, spherical. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles terete or angular, 1–4 mm long; pedicels 1–2 mm long. *Buds* ovoid, 4–6 mm long, 3–5 mm diam.; calyptra as long as hypanthium, hemispherical, apiculate, narrower than hypanthium. *Stamens* all fertile; filaments regularly inflexed; anthers basifixed, subversatile, flattened globoid, dehiscing through short, angled slits. *Fruits* hemispherical to broadly obconical, 3–4-locular, 4–7 mm long, 5–8 mm diam.; calyptra scar flat, c. 0.2 mm wide; stemonophore slightly expanded, flat or slightly raised, to 0.5 mm wide; disc flat or slightly raised, 0.5–1.0 mm wide; valves broadly triangular, obtuse, apically rim level, flat, with small dorsal protuberances. *Seeds* semiglossy, pale red-brown, flattened, elliptic, regularly very shallowly pitted and grooved (almost smooth); hilum ventral; chaff similar.

This taxon is readily distinguished within section *Cneorifoliae* by the extremely narrow adult leaves.

Locally frequent on saline flats in low areas.

Two subspecies are recognised on regional differences in leaf width.

1 Adult leaves less than 3 mm wide ..... **18a**. subsp. **angustissima**

1* Adult leaves more than 4 mm wide ..... **18b**. subsp. **quaerenda**

18a. Eucalyptus angustissima *F. Muell.* subsp. **angustissima**

Adult leaves linear, 7–13 cm long, 2–3 mm wide. *Buds* 5–6 mm long, 4–5 mm diam. *Fruits* 5–7 mm long, 5–8 mm diam. Figure 20.

DISTRIBUTION: Two disjunct occurrences are known, one north of Esperance and west of the Scaddan–Grasspatch area, and one near Israelite Bay (Eyre District). Figure 18.

ECOLOGY: This taxon has a patchy and sporadic distribution, forming open shrublands with *Melaleuca* spp. and with grass and sedge understorey on saline flats and around saltpans.

CONSERVATION STATUS: 3RC (Briggs & Leigh 1988: 118).

SELECTED SPECIMENS (from 11 examined): WESTERN AUSTRALIA (W to E): 4.8 km N from end of made road on Fields Road North (33°04'30"S 121°12'E), *Brooker 9528*, 8 Nov 1986 (CANB, NSW, PERTH); 16.1 km W of highway on Speddingup Road West (Dalyup River), *Hill 2296, Johnson, Blaxell & Brooker*, 7 Nov 1986 (NSW, PERTH); 10 km SW of Israelite Bay on track, *Crisp 4898*, 7 Jan 1979 (CBG, CANB, NSW, PERTH).

18b. Eucalyptus angustissima *F. Muell.* subsp. **quaerenda** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica foliis adultis brevioribus et latioribus etiam planis, alabastris fructibusque minoribus et hypanthio conico praesertim in fructibus differt.

TYPE: WESTERN AUSTRALIA: 100 metres S of the south shore of Lake Chinokup, *K.D. Hill 2460, L.A.S. Johnson & D.F. Blaxell*, 13 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

Adult leaves linear to narrow-lanceolate, 4.5–9 cm long, 4–7 mm wide. *Buds* 4–5 mm long, 3–4 mm diam. *Fruits* 4–6 mm long, 5–7 mm diam. Figure 20.

Subspecies *quaerenda* differs from subspecies *angustissima* in the shorter, broader, flat adult leaves, the smaller buds and fruits and the conical hypanthium (especially in fruits).

DISTRIBUTION: The type form is at present known from the type area only, around the southern and western edges of Lake Chinokup (Figure 18). An early collection by Muir is cited from 'towards the Tone River', the exact locality for which is obscure. It seems unlikely that a member of this group would occur in the wetter country where the Tone River joins the Warren River. The Tone River rises to the northeast near Kojonup, in country approaching a more likely range of habitats. This area has suffered widespread and thorough devastation of native flora during the development of the wheat-farming industry, and this subspecies may have suffered severe reduction of range.

ECOLOGY: A taxon of sand-plain heath on poorly drained, somewhat saline substrates.

Intergrading populations occur with subsp. *angustissima* in country north of Ravensthorpe.

CONSERVATION STATUS: 2V-. Known at present only from around the southern and western shore of Lake Chinokup.

The epithet is from the Latin *quaerendus*, to be sought, applied first at a stage in our investigations when only the early Muir collection was known, but still apt since there are few known localities.

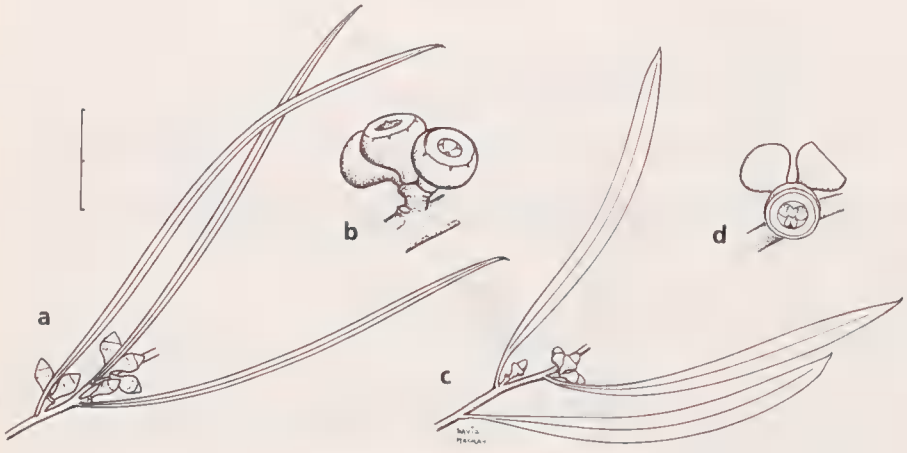

Figure 20. *E. angustissima* subsp. *angustissima*. **a**, adult leaves and buds; **b**, fruits (all from *Hill 2296 et al.*). Subsp. *quaerenda*. **c**, adult leaves and buds; **d**, fruits (all from *Hill 2460 et al.*).

Selected specimens (from 4 examined): Western Australia (W to E): towards the Tone River, *Muir*, 1880 (NSW, MEL); 8.7 km N of Katanning–Pingrup road on Chinocup Road, *Brooker 9566*, 27 Jan 1987 (CANB, NSW, PERTH).

Intergrades between subspecies (from 3 examined): Western Australia: 3.1 km from highway on Fitzgerald Road, *Brooker 8807*, 18 Jan 1985 (CANB, NSW, PERTH).

19. Eucalyptus mannensis *Boomsma*, Trans. & Proc. Roy. Soc. South Australia 88: 115, pl. 1, Figure 1 (1964).

Type citation: 'Holotypus – Northern Territory, 20.3 miles north of Angas Downs Head Station, 15.x.1957, G. Chippendale and L. Johnson 3986 (AD 95951147). Isotypes in N.T., N.S.W., Canb., Bri., Melb., N.E.K., Perth. [sic]'

Mallee to 7 m, often less, sometimes small tree to 8 m. *Bark* persistent, fibrous-flaky on lower stems, smooth above, grey, cream or pinkish red. *Juvenile leaves* disjunct, lanceolate, dull, grey-green, petiolate, 5–10 cm long, 10–25 mm wide. *Adult leaves* disjunct, lanceolate, acuminate, glossy, with abundant oil glands (oil glands black in dried leaves), 6–15 cm long, 8–19 mm wide; petioles 9–17 mm long; lateral veins moderately closely-spaced, at c. 45° to midrib; reticulum close; oil glands abundant; intramarginal vein distinct, within 1 mm of margin. *Umbellasters* axillary, 7– to 11-flowered; peduncles terete, 2–13 mm long; pedicels terete, 1–5 mm long. *Mature buds* ovoid, sometimes elongate, 5–9 mm long, 3–5 mm diam.; calyptra rounded, obtuse or acute, 1–2 times as long as hypanthium. *Stamens* all fertile, outer whorls erect, inner whorls inflexed in bud; anthers subglobular, dorsifixed (attached very low on connective), subversatile, dehiscing by short angled slits. *Fruits* cup-shaped, verrucose, 3-locular, 4–7 mm long, 5–9 mm diam.; calyptra scar and stemonophore distinct, 0.25–0.5 mm wide, flat or slightly raised; disc 1–1.5 mm wide, flat or shallowly depressed; valves triangular, enclosed at bases, vertically raised, each with two dorsal lobes formed from outgrowths from the disc, tips often exserted; style sometimes persistent, remaining attached to one valve in open fruits. *Seeds* flattened-ovoid, dull, dark brown, very shallowly regularly pitted, c. 1 mm long; hilum ventral; chaff paler, smaller, linear or blocky.

The closest affinity of *E. mannensis* is with *E. jutsonii* Maiden, and not with the *E. foecunda* group as supposed by Boomsma in the protologue. *E. jutsonii* is distinguished by the linear adult and juvenile leaves.

Two groups of populations are recognised but as subspecies only, despite the lack of intergrades, since the differences are slight.

1 Adult leaves always glossy, largest leaves usually more than 12 mm wide ..... **19a.** subsp. **mannensis**

1* Adult leaves dull on new growth, largest leaves less than 12 mm wide ..... **19b.** subsp. **vespertina**

19a. Eucalyptus mannensis *Boomsma* subsp. **mannensis**

Adult leaves lanceolate, glossy, 6–15 cm long, 11–19 mm wide. *Peduncles* terete, 5–13 mm long. *Mature buds* 5–9 mm long, 3–4 mm diam. *Fruits* 4–7 mm long, 5–9 mm diam.

Distribution: A taxon of the semidesert country, from the western and south-western edges of the Great Victoria Desert (Wiluna to north of Zanthus) east to north-western South Australia and south-western Northern Territory, to south of Alice Springs. Figure 21.

Ecology: Widespread but sporadic on deep sand on red aeolian desert dunes.

Conservation status: Not considered to be at risk.

SELECTED SPECIMENS (from 40 examined): WESTERN AUSTRALIA (W to E): 29 miles [46 km] S of Wiluna on Sandstone road, *Speck 1452*, 16 Sep 1958 (CANB, NSW); 4.4 km N of Mulga Rock on Lake Minigwal track, *Hill 2670 & Johnson*, 29 Nov 1986 (NSW, PERTH); c. 26 km SE of Giles Meteorological Station, *Lazarides 8322*, 9 May 1977 (CANB, NSW). South Australia: Mann Range, 39 miles [62 km] NE of Mt Davies camp, *Dunlop 2017*, 1 Nov 1970 (DNA, NSW). NORTHERN TERRITORY (W to E): 7 miles [11 km] N of Lake Amadeus, *Chippendale NT 6360*, 28 June 1959 (DNA, NSW); 28.6 km E of Curtin Springs, *Hill 856, Johnson & Benson*, 10 July 1984 (NSW); 50 miles [80 km] S of Tempe Downs, *Forde 186*, 16 June 1956 (DNA, NSW); 116 km N of Kulgera, *Brooker 9438*, 30 Aug 1986 (CANB, NSW); Deep Well road, 34 miles [54 km] S of Alice Springs, *Nelson 1855*, 19 Mar 1969 (DNA, NSW).

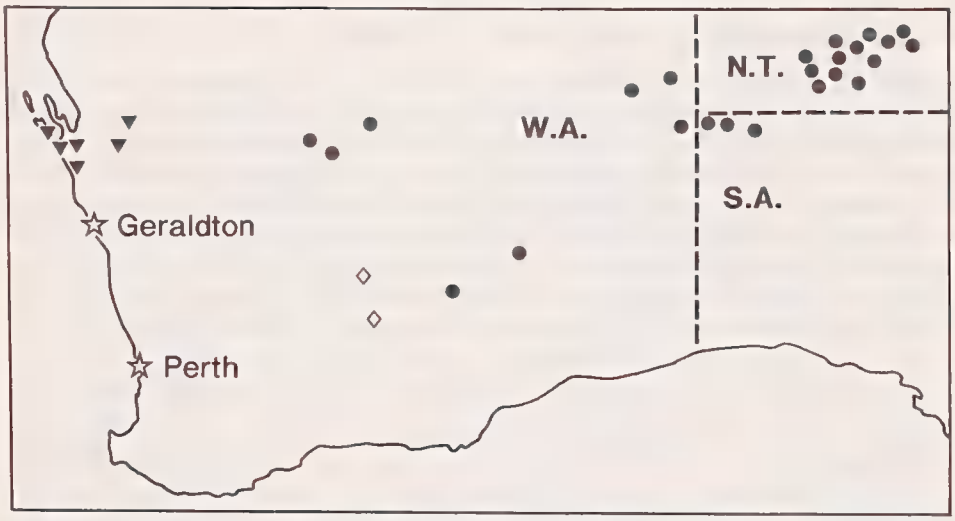

Figure 21. Distribution of *E. mannensis* subsp. *mannensis* (●), subsp. *vespertina* (▼) and *E. jutsonii* (◇).

19b. Eucalyptus mannensis *Boomsma* subsp. **vespertina** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica foliis adultis non nitentibus eis maximis plerumque angustioribus differt.

TYPE: WESTERN AUSTRALIA: 12 km W of road from 'Coburn' to 'Hamelin', *D.F. Blaxell W75/101 & M.I.H. Brooker*, 8 Oct 1975 (holo NSW; iso CANB, PERTH).

Adult leaves narrow-lanceolate to lanceolate, dull, 7–12 cm long, 8–12 mm wide. *Peduncles* terete, 2–8 mm long. *Fruits* 5–6 mm long, 6–8 mm diam. Figure 22.

DISTRIBUTION: Known only from the Shark Bay area. Figure 21.

ECOLOGY: A locally common mallee in red sandhill country.

Subsp. *vespertina* differs from subsp. *mannensis* in the duller and narrower adult leaves.

Subsp. 'western' of Brooker & Kleinig (1990).

CONSERVATION STATUS: Not considered to be at risk.

The epithet is from the Latin *vespertinus*, belonging to the evening or western, in allusion to the subspecies' more westerly distribution.

SELECTED SPECIMENS (from 15 examined): WESTERN AUSTRALIA (W to E): 5 miles [8 km] from Shark Bay road towards Tamala, *Brooker 2394*, 10 Jan 1970 (PERTH, NSW); 6 km N of Wannoo, *Blaxell W75/96 & Brooker*, 8 Oct 1975 (NSW, CANB, PERTH); 65 km S of Wannoo, *Beadle 170*, 2 Oct 1970 (UNE, NSW).

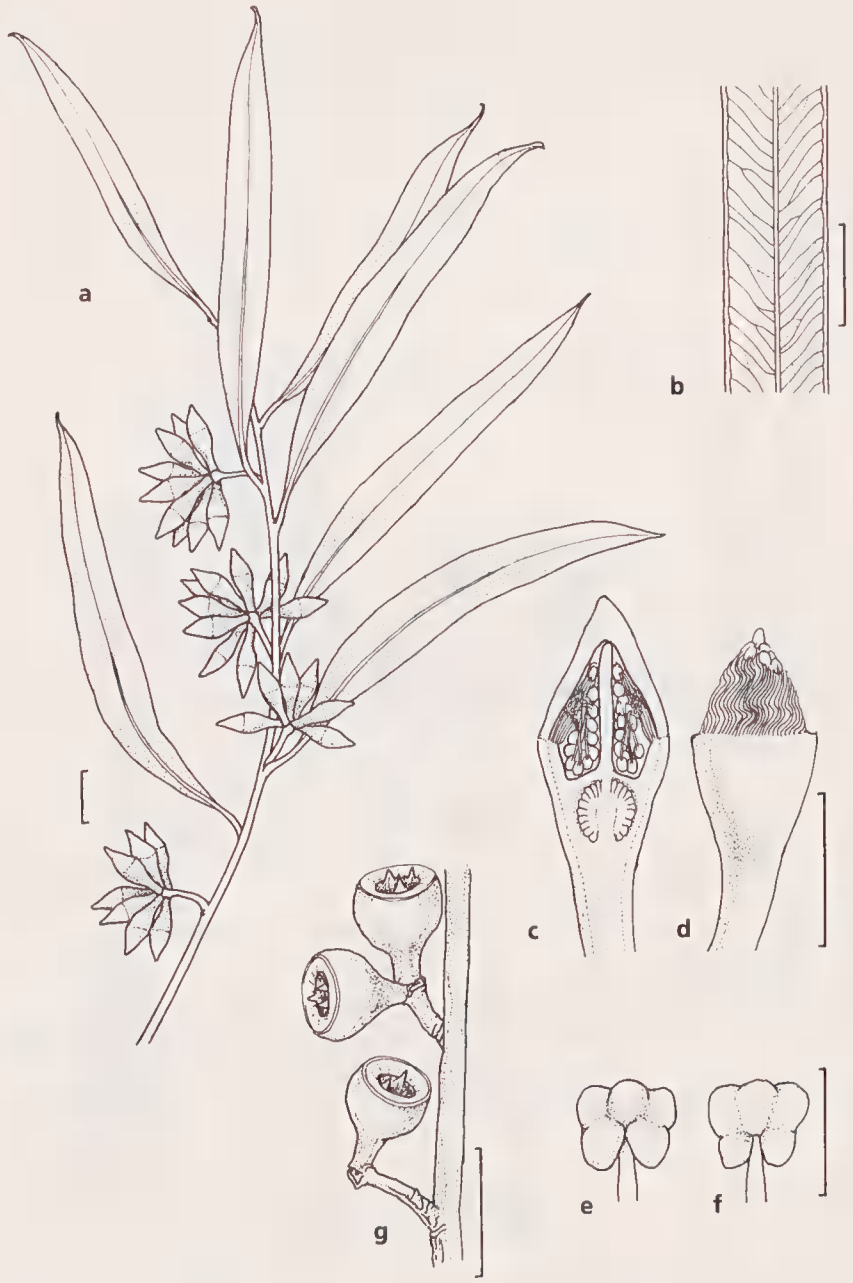

Figure 22. *E. mannensis* subsp. *vespertina*. **a**, adult leaves and buds; **b**, part of adult leaf showing venation; **c**, section of bud; **d**, bud with calyptra removed, showing filament flexure; **e**, **f**, anther; **g**, fruits (all from *Blaxell W75/101*). Scale bar: a, b, g = 1 cm; c, d = 5 mm; e, f = 0.5 mm.

Figure 23. *E. argyphea*. **a**, adult leaves; **b**, buds; **c**, section of bud; **d**, **e**, anther; **f**, fruits; **g**, **h**, seed (all from *Hill 659 et al.*). Scale bar: a, b, c, f = 1 cm; g, h = 1 mm; d, e = 0.5 mm.

Series *Falcatae*

Species 20 to 26 are placed in series *Falcatae*, defined by the combination: pith glands absent; filaments inflexed or irregularly flexed; anthers oblong to ovoid, basifixed, versatile, dehiscing by broad, angled slits; seeds shallowly reticulately pitted, longitudinally grooved, dorsiventrally compressed.

20. Eucalyptus argyphea *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. ornatae* sed alabastris fructibusque minoribus et minus costatim sculptis distinguitur. Inter species affinitatis *E. falcatae* combinatione sequenti characterum distinguitur: habitus arborescens (forma 'mallet'); cortex argenteo-albus; alabastra parva non vel vix sculpta; fructus parvi non valde sculpti, nitidi. Pedunculi pedicellique longi et graciles sunt.

Type: Western Australia: 12 km W of Harrismith on road to Wickepin (32°55'S, 117°44'E), *K.D. Hill 659, L.A.S. Johnson, D.F. Blaxell, M.I.H. Brooker, S.D. Hopper*, 8 Nov 1983 (holo NSW; iso CANB, PERTH).

[*Eucalyptus* sp. J of Brooker & Kleinig (1990)]

Tree (mallet) to 15 m, trunk straight to c. 5 m. *Bark* smooth, shining pale silver-grey or white. *Juvenile leaves* opposite for many nodes, elliptic, acute or apiculate, to 4 cm long, 25 mm wide, petioles to 6 mm long. *Adult leaves* disjunct, lanceolate, usually falcate, acute or acuminate, ± glossy, 5–10 cm long, 11–16 mm wide; petioles 10–16 mm long; lateral veins at 30–40° to midrib, ± closely-spaced, densely reticulate between; intramarginal vein distinct, 0.5–1.0 mm from margin. *Umbellasters* axillary, 7-flowered; peduncles terete, 9–13 mm long, slender; pedicels terete, 5–8 mm long, slender. *Mature buds* broad-conical, apically narrow-conical, 16–21 mm long, 5–7 mm diam.; calyptra narrow-conical, narrower than hypanthium, 2.5–3.5 times longer than hypanthium. *Fruits* globular, sometimes ribbed, 3-locular, apically constricted, 6–8 mm long, 5–7 mm diam.; calyptra scar flat, continuous with hypanthium, c. 0.5 mm wide; stemonophore distinct, flat, c. 1 mm wide; disc flat, c. 1 mm wide, separated from stemonophore by a groove, enclosing valve bases and sometimes breaking apart on dehiscence; style persistent, splitting into 3 on dehiscence and giving valves an attenuate appearance; valves and style remnants vertically exserted. *Seeds* glossy dark grey, elliptic, shallowly reticulate, 1.5–2.0 mm long; chaff smaller, reddish brown, angular. Figure 23.

Nearest to *E. ornata* Crisp, from which it differs in the generally smaller and less ribbed buds and fruits. Distinguished within the *E. falcata* Turcz. group by the tree (mallet) habit, the silver-white bark, the small, almost smooth buds (16–21 mm long, 5–7 mm diam.), and the small, often smooth, glossy fruits (6–8 mm long, 5–6 mm diam.). Peduncles and pedicels are relatively long (9–13 and 5–8 mm respectively) and slender.

Distribution: Restricted to the southern Wheat Belt, from Harrismith to south of Lake King (Avon and Roe Districts). Figure 24.

Ecology: A localised species in mallet woodlands on fairly level, pale sandy loams, but often on slight residual lateritic rises, with *E. gardneri* Maiden and *E. longicornis* (F. Muell.) F. Muell. ex Maiden. Once used for tanbark but now extensively cleared for wheatlands.

Conservation status: 3R. The range of this species lies almost wholly within agricultural country that has been extensively and indiscriminately cleared.

Intergrades are recorded with *E. ornata*.

The specific epithet is from the Greek *argypheos*, silvery white, in reference to the striking and distinctive silvery bark of the trunk. The stress is on the second syllable, in English contexts pronounced 'jif'.

SELECTED SPECIMENS (from 16 examined): WESTERN AUSTRALIA (W to E): 13.3 km S of Brookton–Corrigin road on Dudinin road, *Hill 2990*, 31 Aug 1988 (NSW); 8.3 km N of Nyabing on Kukerin North Road, *Brooker 9143*, 9 Dec 1985 (CANB, NSW, PERTH); 6.7 km E of Needilup North Road on Ryans Road, *Hill 3135*, 7 Sep 1988 (NSW); 25.0 km W of Lake King towards Newdegate, *Hill 2392, Johnson, Blaxell & Brooker*, 9 Nov 1986 (NSW, PERTH); 4.6 km W of Hatters Hill Road on Lake King–Norseman road, *Brooker 8682*, 8 Sep 1984 (CANB, NSW, PERTH).

Intergrades with *E. ornata*: 43.5 km W of Lake King–Hyden road on Holt Rock–Kulin road, *Johnson 9188 & B.G. Briggs*, 1 Nov 1988 (NSW); Hatters Hill, *Mollemans 2710*, 26 May 1990 (NSW, PERTH, CANB).

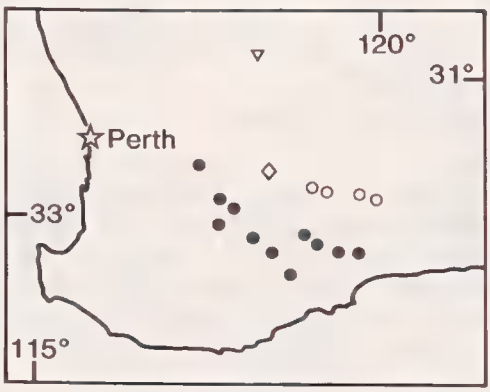

Figure 24. Distribution of *E. argyphea* (●), *E. recta* (▽), *E. ornata* (◇) and *E. argyphea–E. ornata* intergrades (○).

21. Eucalyptus recta *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. falcatae* combinatione sequenti characterum distinguitur: habitus arborescens (forma 'mallet'); cortex argenteus vel albus; alabastra magna, sculpti in costas latas et non profundas; calyptra longa, acuta; fructus magna; pedunculi pedicellique longi.

TYPE: WESTERN AUSTRALIA: corner of Cadoux–Koorda road and Johnson Road, *K.D. Hill 2504, L.A.S. Johnson & D.F. Blaxell*, 16 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH)

Tree (mallet) to 15 m, trunk straight to c. 5 m. *Bark* smooth, shining pale silver-grey or white. *Juvenile leaves* opposite for many nodes, elliptic, acute or apiculate, to 4 cm long, 25 mm wide, petioles to 6 mm long. *Adult leaves* disjunct, lanceolate, usually falcate, acute or acuminate, ± glossy, 5–10 cm long, 11–16 mm wide; petioles 10–16 mm long; lateral veins at 30–40° to midrib, ± closely-spaced, densely reticulate between; intramarginal vein distinct, 0.5–1.0 mm from margin. *Umbellasters* axillary, 7-flowered; peduncles terete, 15–25 mm long, slender; pedicels terete, 9–18 mm long, slender. *Mature buds* broad-conical, apically narrow-conical, 22–25 mm long, 8–9 mm diam.; calyptra narrow-conical, narrower than hypanthium, 2.5–3.5 times longer than hypanthium. *Fruits* depressed-globular, distinctly ribbed, 3-locular, apically con-

stricted, 8–9 mm long, 10–12 mm diam.; calyptra scar flat, continuous with hypanthium, c. 0.5 mm wide; stemonophore distinct, flat, c. 1 mm wide; disc flat, 1–2 mm wide, separated from stemonophore by a groove, enclosing valve bases and sometimes breaking apart on dehiscence; style persistent, splitting into 3 on dehiscence and giving valves an attenuate appearance; valves and style remnants vertically exserted. *Seeds* glossy dark grey, elliptic, shallowly reticulate, 1.5–2.0 mm long; chaff smaller, reddish brown, angular. Figure 25.

Nearest to *E. ornata* Crisp, from which it differs in the larger buds (buds 14–20 mm long in *E. ornata).* Distinguished in the *E. falcata* group by the tree habit, the white bark, the large buds (22–25 mm long, 8–9 mm diam.) which are broadly shallowly ribbed, the long, acute calyptra, the large fruits (8–9 mm long, 10–12 mm diam.). Pedicels and peduncles are relatively long (15–25 and 9–18 mm respectively).

Distribution: Known from a small area near Cadoux (Avon District), well separated from the occurrence of *E. ornata*. Figure 24.

Ecology: Locally frequent but very restricted, in mallet woodlands with *E. gardneri* Maiden, slightly above the surrounding country, as in the cases of *E. argyphea* and *E. ornata*.

Conservation status: 2V. Known only from a restricted area that lies wholly within agricultural country and has been extensively cleared.

The epithet is from Latin *rectus*, straight, referring to the straight trunks.

Selected specimens (from 5 examined): Western Australia (N to S): c. 3 miles [5 km] E of Cadoux, *B. Smith 644*, 13 Feb 1986 (MEL, CANB, HO, NSW, PERTH); *Brooker 9381*, 2 July 1986 (CANB, NSW, PERTH); near Manmanning, *B. & M. Smith*, 13 Feb 1985 (CBG 8600356, NSW).

22. Eucalyptus balanopelex *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. semiglobosae* sed characteribus sequentibus distinguitur: folia adulta minora angustioraque, pedicelli longiores et calyptra major longiorque.

Type: Western Australia: 0.5 km from Fisheries road on Coolinup Road, *K.D. Hill 2285 & L.A.S. Johnson*, 6 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

Mallee to 4 m. *Bark* smooth throughout, grey or light brown. *Adult leaves* disjunct, similifacial, broad-lanceolate, acute or acuminate, 5–12 cm long, 7–28 mm wide; petioles 10–23 mm long, flattened; lateral veins moderately spaced, regular, at 30–45° to midrib; reticulum regular; oil glands medium size, sparse; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles terete, 10–20 mm long; pedicels terete, 5–11 mm long. *Mature buds* ovoid, smooth or shallowly ribbed, c. 16 mm long, c. 9 mm diam.; calyptra conical, convex, obtuse or rounded, c. 1.5 times longer than hypanthium. *Stamens* all fertile; filaments regularly inflexed; anthers shortly oblong, dorsifixed, versatile, dehiscing through short parallel slits. *Fruit* globular-truncate, usually somewhat ribbed, 3–4-locular, 8–10 mm long, 10–12 mm diam.; calyptra scar flat, 0.3–1.0 mm wide; inner growth zone scar flat, 0.5–1.0 mm wide; stemonophore elevated 0.5–1.0 mm above scar, flat, 0.5–1.0 mm wide; disc ± vertically depressed, c. 1–2 mm wide; valves narrowly triangular, long apiculate with persistent style remnants, basally deeply enclosed, apically vertically exserted, to 5 mm long. Figure 26.

E. balanopelex differs from *E. semiglobosa* (Brooker) L. Johnson & K. Hill in the larger buds with a larger and longer calyptra, the longer pedicels and the smaller and narrower adult leaves. It occurs in a swampy sandplain habitat in contrast to the granite shelf habitat of *E. semiglobosa*.

Figure 25. *E. recta*. **a**, adult leaves; **b**, buds; **c**, section of bud; **d**, **e**, anther; **f**, fruits; **g**, **h**, seed (**a** – **e** from *Smith 644*, **f** – **h** from *Brooker 9381*). Scale bar: a, b, c, f = 1 cm; d, e, g, h = 1 mm.

DISTRIBUTION: Known only from two populations in the subcoastal area east of Esperance (Eyre District). Figure 27.

ECOLOGY: This is an uncommon species, occurring in small stands in mallee heathland on swampy white or grey sandplain.

CONSERVATION STATUS: 2V. Of restricted occurrence in an area that is suffering active agricultural development.

The epithet is from the Greek *balanos*, an acorn, and *pelex*, a helmet, referring to the shape of the calyptra. The stress is on the penultimate syllable, because of the long 'e' (eta) in the Greek.

SELECTED SPECIMENS (from 5 examined): WESTERN AUSTRALIA: 14 km from Fisheries Road on Merivale Road, *L. Johnson 9067 & M. Johnson*, 14 May 1988 (NSW, CANB, MEL, PERTH); 30.1 miles [48 km] E of Esperance, *Chippendale 400*, 25 Mar 1968 (CANB, NSW, PERTH).

Figure 26. *E. semiglobosa*. **a**, adult leaves and buds; **b**, fruits (all from *Brooker 3613*). *E. balanopelex*. **c**, adult leaves and buds; **d**, fruits (all from *Hill 2285 & Johnson*). Scale bar = 1 cm.

23. Eucalyptus semiglobosa *(Brooker) L. Johnson & K. Hill*, **stat. nov.**

Basionym: *Eucalyptus goniantha* Turcz. subsp. *semiglobosa* Brooker, Nuytsia 2: 110 (1976).

Type citation: 'Type: Between Mt Le Grand and Frenchmans Peak, Western Australia (33°59'S, 122°08'E) 22 April 1972, *M.I.H. Brooker 3613* (holo FRI [now CANB]; iso PERTH, NSW, K, AD, MEL, BRI).'

Mallee to 4 m. *Bark* smooth throughout, grey or light brown. *Adult leaves* disjunct, similifacial, broad-lanceolate, acute or acuminate, 6–12 cm long, 18–38 mm wide; petioles 12–32 mm long, ± quadrangular; lateral veins moderately spaced, regular, at 30–45° to midrib; reticulum regular; oil glands medium size, sparse; intramarginal vein continuous, distinct, 0.5–1.0 mm from margin. Inflorescences simple, axillary; umbellasters 7-flowered; peduncles terete, 9–21 mm long; pedicels terete, 2–8 mm long. *Mature buds* ovoid, smooth or shallowly broadly ribbed, 9–11 mm long, 7–9 mm diam.; calyptra hemispherical or oblong, rounded, about as long or slightly longer than hypanthium. *Stamens* all fertile; filaments regularly inflexed; anthers shortly oblong, dorsifixed, versatile, dehiscing through short parallel slits. *Fruit* globular-truncate, usually somewhat ribbed, 3–4-locular, 8–10 mm long, 10–14 mm diam.; calyptra scar flat, 0.3–1.0 mm wide; inner growth zone scar flat, 0.5–1.0 mm wide; stemonophore elevated 0.5–1.0 mm above scar, flat, 0.5–1.0 mm wide; disc ± vertically depressed, c. 1–2 mm wide; valves narrowly triangular, long apiculate with persistent style remnants, basally deeply enclosed, apically vertically exserted, to 5 mm long. Figure 26.

This taxon is distinguished from *E. goniantha* Turcz. by the elongate pedicels and peduncles and the relatively short, broad calyptra. Recent discovery of *E. goniantha* subsp. *notactites* (see below) within a few hundred metres of the type locality of *E. semiglobosa* indicates that the two are almost sympatric and show little interbreeding. Subspecific status is thus not appropriate. Its sister species is probably *E. balanopelex*, and the two together are then closest to *E. falcata*, with a more distant relationship with *E. goniantha*.

Distribution: Scattered and very sporadic, from Cape Le Grand to Cape Arid (Eyre District). Figure 27.

Ecology: Known from a few stands only, on shallow sandy soil on subcoastal granite domes east of Esperance.

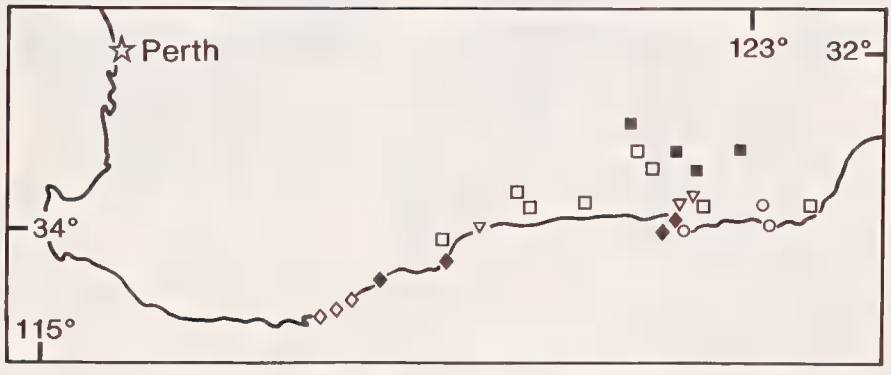

Figure 27. Distribution of *E. goniantha* subsp. *goniantha* (◇), subsp. *notactites* (◆), *E. kessellii* subsp. *kessellii* (■), subsp. *eugnosta* (□), *E. balanopelex* (▽) and *E. semiglobosa* (○).

CONSERVATION STATUS: 2RC. Stands of this species occur in Cape Le Grand and Cape Arid National Parks.

SELECTED SPECIMENS (from 8 examined): WESTERN AUSTRALIA: Whalebone to Quoin Head, *Brooker 10152*, 13 Dec 1988 (CANB, NSW, PERTH); Boyatup Hill, *Pullen 10085*, 18 Dec 1974 (CANB, NSW); SE side and base of Mt Arid, *Hardie 13*, 23 Nov 1985 (NSW); 300 metres E of old Hill Springs homestead, SE side of Mt Arid, *Hill 3161*, 8 Sep 1988 (NSW, AD, CANB, MEL, PERTH).

24. Eucalyptus goniantha *Turcz.*, Bull. Soc. Imp. Nat. Moscou 20(1): 163 (1847).

TYPE CITATION: 'Nova Hollandia, Drum, n. 71.'

TYPE: WESTERN AUSTRALIA: King George Sound, Swan River Colony, *J. Drummond, 3rd collection no. 71*, 1845 (holo LE; iso BM, CGE, E, FI, G, K, W).

≡ *E. incrassata* Labill. var. *goniantha* Maiden, Crit. Revis. Eucalyptus 1: 103 (1904).

The name *E. goniantha* was misapplied by Bentham (1867) to the taxon shown to be *E. kessellii* by critical examination of the types (see below). This misapplication was followed by subsequent authors. Both Maiden and Blakely recognised the type form of *E. kessellii* as a distinct taxon (see below), but persisted with the misapplication for the more widespread and less distinctive form discussed below. Brooker & Kleinig (1990) correctly apply the names *E. goniantha* and *E. kessellii*, although they include *E. semiglobosa* (above) in the former, and illustrate fruits of *E. kessellii* as *E. goniatha*.

Mallee to 6 m, rarely a tree. *Bark* smooth, grey to brown or orange, shedding in patchily adherent scales, especially on lower trunk. *Branchlets* winged, glaucous. Juvenile leaves disjunct, petiolate, ovate to orbicular, to 13 cm long, 8 cm wide. *Adult leaves* disjunct, broad-lanceolate to ovate, acute to acuminate, dull, 6–15 cm long, 10–50 mm wide; petioles angular, 9–25 mm long, angles decurrent; lateral veins at 30–45° to midrib, ± closely spaced, regular, densely reticulate between; intramarginal vein distinct, 1–2 mm from margin. *Umbellasters* axillary, 7–11-flowered; peduncles strongly winged, 7–16 mm long, to 7 mm wide apically; pedicels 0–5 mm long, to 3 mm wide. *Mature buds* elongate-ovoid, apically constricted, hypanthium ± 2-winged, 8–17 mm long, 5–7 mm diam.; calyptra conical, obtuse, with a distinct median constriction, 1–1.5 times longer than hypanthium. *Stamens* all fertile; filaments regularly inflexed in bud, kinked at point of flexure; anthers shortly oblong, dorsifixed, versatile; cells divergent, dehiscing by short slits. *Fruits* globular to hemispherical, apically constricted, 3–4-locular, 6–9 mm long, 6–11 mm diam.; calyptra scar distinct, recessed, flat, c. 0.5 mm wide; disc 1.5–2 mm wide, depressed at c. 45°; valves deeply enclosed basally, vertically exserted, long-acuminate with remains of persistent style fused to each valve. *Seeds* semiglossy, dark grey to black, elliptic, shallowly reticulate, 1.5–2.0 mm long; hilum ventral; chaff smaller, angular, glossy red-brown.

Distinguished within the series by the combination: bark smooth; juvenile leaves broad; peduncles and pedicels short, thick; fruits rounded, apically contracted.

Two geographic subspecies are recognised chiefly on differences in pedicel length.

1 Pedicels more than 2 mm long ..... **24a.** subsp. **goniantha**

1* Pedicels less than 1 mm long or absent ..... **24b.** subsp. **notactites**

24a. Eucalyptus goniantha *Turcz.* subsp. **goniantha**

Branchlets winged, not glaucous. *Adult leaves* disjunct, lanceolate to broad-lanceolate, acute to acuminate, dull, 8–11 cm long, 10–20 mm wide; petioles 9–25 mm long.

7–11-flowered; peduncles 7–10 mm long, to 0.7 mm wide apically. *Pedicels* more than

2 mm long. *Buds* 8–14 mm long, 4–6 mm diam. *Fruits* pedicellate, hemispherical, 6–8 mm long, 6–9 mm diam.

DISTRIBUTION: Known only from a few headlands and subcoastal hills in the Two Peoples Bay area (Menzies District). Figure 27.

ECOLOGY: Locally frequent but very restricted in distribution, in dense coastal shrub heath on shallow sandy soils.

Isolated occurrences of intergrading forms with *E. falcata* Turcz. (sens. lat.) are known.

CONSERVATION STATUS: 2RC.

SELECTED SPECIMENS (from 5 examined): WESTERN AUSTRALIA: walking track on Flinders Peninsula, *Brooker 9993*, 20 July 1988 (CANB, NSW, PERTH); c. 3 km W of Manypeaks, *Brooker 9822*, 26 Nov 1987 (CANB, NSW, PERTH); West Ridge, Two Peoples Bay, *Brooker 7191*, 15 Nov 1981 (CANB, NSW, PERTH).

***E. falcata* sens. lat. – *E. goniantha* subsp. *goniantha* intergrade:** 26 km E of Bakers Junction on road to Manypeaks, *Brooker 8738*, 29 Nov 1984 (CANB, NSW, PERTH).

24b. Eucalyptus goniantha *Turcz.* subsp. **notactites** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica ramulis novellis et pedunculis valde alatis; foliis longioribus crassioribusque et fructibus plus sessilibus differt.

TYPE: WESTERN AUSTRALIA: Mt Melville garbage tip, 16.5 km from highway, *K.D. Hill 2429, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 12 Nov 1986 (holo NSW; iso PERTH).

Branchlets winged, glaucous. *Adult leaves* disjunct, broad-lanceolate to ovate, acute to acuminate, dull, 6–15 cm long, 15–50 mm wide; petioles 9–25 mm long. *Umbellasters* 7–11-flowered; peduncles 9–16 mm long, to 0.7 mm wide apically. *Mature buds* sessile or on short pedicels (to 1 mm long), hypanthium ± 2-winged, 11–17 mm long, 5–7 mm diam. *Fruits* globular, sessile, ± 2-winged, 6–8 mm long, 8–10 mm diam. Figure 28.

Subsp. *notactites* differs from subsp. *goniantha* in the more sessile buds and fruits, the strongly winged young branchlets and peduncles, and the longer, thicker leaves.

It was referred to as *E. goniantha* subsp. 'sessile fruit', by Brooker & Kleinig (1990).

DISTRIBUTION: This taxon has a very scattered, sporadic distribution from Mt Melville in the Cape Riche area east to Cape Le Grand, with a large disjunction in the range. Figure 27.

ECOLOGY: Locally frequent on shallow sand on laterite or on white sand, known only from sites very near the sea.

CONSERVATION STATUS: 3RC.

The epithet is from the Greek *notos*, the south, and *aktites*, a watcher, from the subspecies' occurrence on the south-facing oceanic coast.

SELECTED SPECIMENS (from 10 examined): WESTERN AUSTRALIA (W to E): Konkoberup Hill (Mt Melville), *Brooker 8945*, 12 Apr 1985 (CANB, NSW, PERTH); Cape Riche, *Diels 3504*, 18 July 1901 (B, NSW); 5.5 km S of Borden–Bremer Bay road on Reef Beach Road, *Brooker 8872*, 2 Mar 1983 (CANB, NSW, PERTH); c. 2 km W of Hood Point, *Brooker 9918*, 9 Mar 1988 (CANB, NSW, PERTH); Cape Le Grand, *Hill 3156*, 8 Sep 1988 (NSW, CANB, PERTH); Sandy Hook Island near Esperance (34°04'S, 122°20'E), *Brooker 7492, 7493*, 1 May 1982 (CANB, NSW, PERTH).

Intergrades between the subspecies: Cheyne Beach, 1 km along track to Mermaid Point, *Brooker 7170*, 14 Nov 1981 (CANB, NSW, PERTH).

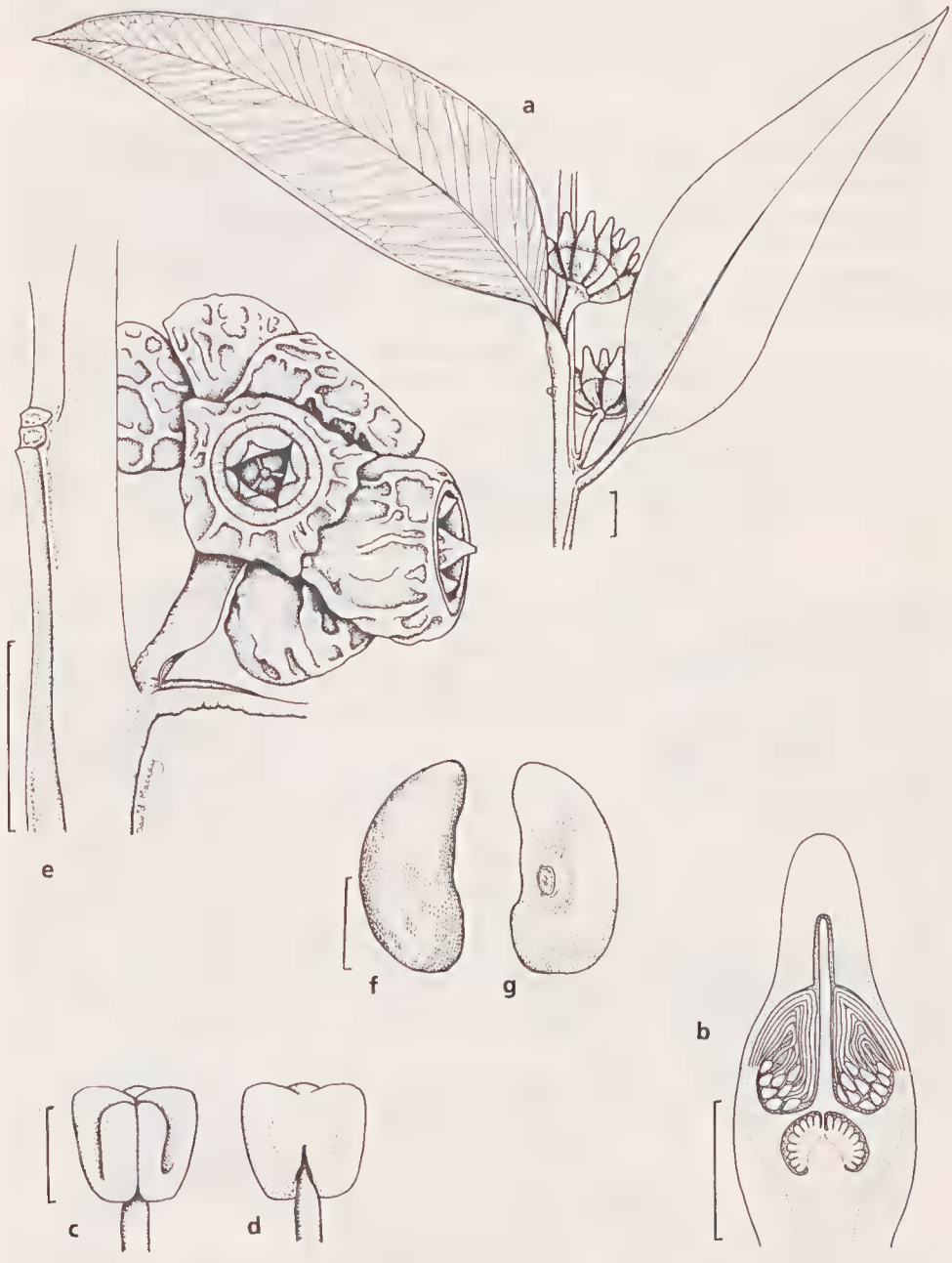

Figure 28. *E. goniantha* subsp. *notactites*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (a – d from *Brooker 7492*, e – g from *Brooker 7493*); Scale bar: a, f = 1 cm; b = 5 mm; g, h = 1 mm; d, e = 0.5 mm.

25. Eucalyptus kessellii *Maiden & Blakely*, J. & Proc. Roy. Soc. New South Wales 59: 187 (1925).

TYPE CITATION: 'Known only from Western Australia. Found in sandy loam in Mallee thickets at a place called Salmon Gums, 66 miles north of Esperance (W.P. Brown per C.A. Gardner, no. 944a; the type).'

TYPE: holo NSW; iso PERTH.

[*E. goniantha* auct. plur. non Turcz.: Bentham (1867); Maiden, Crit. Revis. Eucalyptus 2: 200 (1912); Blakely (1934); Gardner (1960); Chippendale (1973); Chippendale (1988); Brooker & Kleinig (1990: 216, photograph of fruits). Both Maiden and Blakely recognised the type form of *E. kessellii* as a taxon distinct from the less coarse and more widely known form which they regarded incorrectly as *E. goniantha*, and which we separate as a subspecies of *E. kessellii*, below. Gardner (1960) included *E. kessellii* in *E. goniantha*, and was followed by Chippendale (1973, 1988).]

[*E. corrugata* auct. non Luehmann, Victorian Nat. 13: 168 (1897). The binomial *E. corrugata* was also published as a *nomen nudum* by Diels & Pritzel (1905: 443), and that publication was then cited (as *E. corrugata* Luehmann ex Diels) as a synonym of *E. goniantha* (in the incorrect application of the latter name) in Index Kewensis. The Diels publication cites the same specimen as the type in Luehmann's earlier publication, a Sayer collection from near Southern Cross, which is a specimen of *E. corrugata* Luehmann, and collected at a great distance from the nearest occurrence of *E. goniantha*.]

Tree or mallee to 10 m. *Bark* persistent for basal 0.5–3 m, dark grey, coarsely fibrous, then smooth, grey, pink and pale brown. *Juveniles leaves* disjunct, ovate to orbicular, to 12 cm long, 8 cm wide, becoming broad-lanceolate. *Adult leaves* disjunct, lanceolate to broad-lanceolate, acute or acuminate, similifacial, 7–14 cm long, 22–34 mm wide; petioles 10–22 mm long; lateral veins regular, at 30–40° to midrib; oil glands densely packed. *Inflorescences* simple, axillary; umbellasters 3–7-flowered; peduncles thick, angular or ± flattened, 12–25 mm long; pedicels angular, 1–4 mm long. *Buds* broadly ovoid, almost smooth to prominently ribbed, 13–25 mm long, 10–15 mm diam.; calyptra conical, often beaked, smooth to ribbed. *Stamens* all fertile; filaments regularly inflexed; anthers ovoid, versatile, dorsifixed low on connective gland, dehiscing through lateral pores. *Fruits* obconical, almost smooth to prominently ribbed, 4–5-locular, 10–18 mm long, 12–18 mm diam.; calyptra scar raised at c. 45°, 1.5–2 mm wide; stemonophore ± raised, 0.5–1.0 mm wide, usually splitting due to greater differential growth in underlying hypanthium; disc flat, ultimately markedly incurved, 2–3 mm wide; valves narrowly triangular, long-apiculate with persistent style remnants, basally deeply enclosed, apically vertically exserted, to 7 mm long.

Two geographic subspecies are recognised on differences in fruit ornamentation.

1 Fruits distinctly ribbed, ribs more than 1 mm high ..... **25a.** subsp. **kessellii**

1* Fruits smooth or with ribs less than 1 mm high ..... **25b.** subsp. **eugnosta**

25a. Eucalyptus kessellii *Maiden & Blakely* subsp. **kessellii**

Bark persistent on lower trunk. *Buds* and fruits prominently ribbed. *Umbellasters* sometimes 3-flowered. Figure 29.

DISTRIBUTION: This subspecies occupies a zone to the north and north-east of Esperance, from around Salmon Gums to north-east of Mt Ney. Figure 27.

ECOLOGY: Locally frequent in tall mallee woodland on flat sites on pale sandy often somewhat calcareous clay-loams, often with woodland species such as *E. creta*

L. Johnson & K. Hill and *E. oleosa* F. Muell. ex Miq. (sens. lat.).

CONSERVATION STATUS: Not considered to be at risk.

SELECTED SPECIMENS (from 7 examined): WESTERN AUSTRALIA (W to E): 28 km NE of Mt Ridley on track, *Blaxell 86/091, Johnson, Hill & Brooker*, 5 Nov 1986 (NSW); Mt Ney Road, *Brooker 8928*, 10 Apr 1985 (CANB, NSW, PERTH); 30 miles [50 km] NE of Mt Ney, *Beard 6377*, 17 Sep 1970 (PERTH, NSW).

25b. Eucalyptus kessellii *Maiden & Blakely* subsp. **eugnosta** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica umbellastris regulariter 7-floris et alabastris fructibusque minoribus et prominenter costatis differt.

TYPE: WESTERN AUSTRALIA: 15.2 km W of highway on Speddingup West Road, *K.D. Hill 2297, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 7 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

Figure 29. *E. kessellii* subsp. *kessellii*. **a**, adult leaves and buds; **b**, fruits (all from *Brooker 8928*). Subsp. *eugnosta*. **c**, adult leaves and buds; **d**, fruits (all from *Hill 2297 et al.*). Scale bar = 1 cm.

Bark smooth. *Buds* and fruits smooth to shallowly ribbed. *Umbellasters* 7-flowered. Figure 29.

Distinguished from subsp. *kessellii* by the smooth bark, the consistently 7-flowered umbellasters, and the smooth or less prominently ribbed buds and fruits.

Distribution: Subsp. *eugnosta* occurs to the south of subsp. *kessellii*, nearer the coast. It also ranges further in both easterly and westerly directions, from about the Hamersley River east almost to Israelite Bay (Eyre District). Figure 27.

Ecology: Locally frequent in mixed mallee scrub on pale sandy soils, often over laterites. This taxon occurs in a more typical 'sand plain mallee' habitat and community than subsp. *kessellii*.

Hybrids are recorded with *E. falcata* Turcz. (sens. lat.).

Conservation status: Not considered to be at risk.

The epithet is from the Greek *eugnostos*, well-known or familiar, this being the better-known race of *E. kessellii*, though not the one that includes the nomenclatural type.

Selected specimens (from 13 examined): Western Australia (W to E): 3.5–4 miles [5.5–6.5 km] N of Mt Bland, Fitzgerald River Nat. Park, *Tindale 3854a*, 30 Aug 1973 (NSW, PERTH); 8.8 miles [14 km] SE of Jerdacuttup River crossing on highway, *Tindale 3814*, 28 Aug 1973 (NSW, PERTH); 90 km W of Esperance on Ravensthorpe road, *Blaxell 1687*, 22 June 1978 (NSW, PERTH); 31.2 miles [50 km] E of Esperance, *Chippendale 401*, 25 Mar 1968 (CANB, NSW); c. 2.5 km from Israelite Bay track on Mt Ragged track, *Brooker 8914*, 8 Apr 1985 (CANB, NSW, PERTH).

Intergrades between the subspecies: Western Australia: 45.2 miles [72 km] W of Esperance, *Chippendale 193*, 15 Mar 1967 (CANB, NSW); 29.7 miles [47.5 km] E of Esperance, *Brooker 2506*, 15 Feb 1970 (PERTH, NSW).

E. falcata* sens. lat. x *E. kessellii* subsp. *eugnosta: Western Australia: 90 km W of Esperance on Ravensthorpe road, *Blaxell 1691*, 22 June 1978 (NSW, PERTH).

26. Eucalyptus balladoniensis *Brooker*, Nuytsia 2(2): 103, Figure 1, 2 (1976).

Type citation: '80 km by road south of Zanthus towards Balladonia, W.A. (31°37'S, 123°53'E); *M.I.H. Brooker 2471*, 13.2.1970 (holo PERTH; iso FRI [now CANB], NSW).'

Type: The Holotype specimen (in PERTH) is from the Balladonia race (subspecies *balladoniensis*, with pedicellate fruit), although the citation refers to a locality where the Zanthus race (subsp. *sedens*, with sessile buds and fruits) is known to occur. All other specimens from the cited locality match the Zanthus race, including supposed duplicates of the Type (cited as distributed to FRI [now CANB] and NSW but actually held in PERTH). The actual Holotype bears no field collection tag, whereas the 'duplicates' bear 'Brooker 2471' tags. The protologue description and illustration are consistent with the Balladonia race, and Brooker (pers. comm.) states that specimens have apparently been mixed, and that the protologue was drawn up from the Balladonia material. The untagged specimen in PERTH is hence regarded as the Holotype. The cited locality and details do not correspond to this specimen, and are regarded as erroneous. The Holotype matches a later collection (*Brooker 3653*) from 20 km W of Balladonia on Highway 1, and this can be regarded as the type locality.

Mallee to 10 m. *Bark* persistent for basal 0.5–3 m, then smooth, grey and pale brown. *Juveniles leaves* disjunct, linear, to 8 cm long, 5 mm wide, becoming lanceolate. *Adult leaves* disjunct, lanceolate, acute or acuminate, similifacial, 7–13 cm long, 12–25 mm wide; petioles 10–22 mm long; lateral veins regular, at 30–40° to midrib; oil glands densely packed. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles thick, angular or ± flattened, 6–20 mm long; pedicels angular, 1–9 mm long. *Buds* ovoid,

distinctly broadly beaked, 17–22 mm long, 8–11 mm diam.; calyptra broadly rostrate. *Stamens* all fertile; filaments regularly inflexed; anthers ovoid, versatile, dorsifixed low on connective gland, dehiscing through lateral pores. *Fruits* obconical to cup-shaped or broadly hemispherical, apically ± constricted, 4–5-locular, 7–11 mm long, 8–12 mm diam.; calyptra scar raised at c. 45°, 1.5–2 mm wide; stemonophore ± raised, 0.5–1.0 mm wide, usually splitting due to greater differential growth in underlying hypanthium; disc flat, ultimately markedly incurved, 2–3 mm wide; valves narrowly triangular, long-apiculate with persistent style remnants, basally deeply enclosed, apically vertically exserted, to 7 mm long.

Two subspecies are recognised on differences in pedicel length.

1 Pedicels more than 6 mm long ..... **26a.** subsp. **balladoniensis**

1* Pedicels 0–2 mm long ..... **26b.** subsp. **sedens**

26a. Eucalyptus balladoniensis *Brooker* subsp. **balladoniensis**

Mallee to 10 m. *Bark* persistent for basal 0.5–3 m, then smooth, grey. *Adult leaves* 7–13 cm long, 13–25 mm wide; petioles to 22 mm long. *Peduncles* terete or angular, 9–16 mm long; pedicels terete, 6–9 mm long. *Fruits* 7–11 mm long, 8–12 mm diam.

In general, the pedicels are longest in the southern part of the subspecies' range.

Distribution: Scattered from Mt Ridley north and east almost to Balladonia (Roe and Coolgardie Districts). Figure 30.

Ecology: Locally frequent in mallee woodland, often as an understorey species, on sandy calcareous soils.

Conservation status: Not considered to be at risk.

Selected specimens (from 11 examined): Western Australia (W to E): 7.1 km NE of Mt Ridley turnoff on Dempster Road, *Hill 2251, Johnson, Blaxell & Brooker*, 5 Nov 1986 (NSW, CANB, CBG, MEL, PERTH); 13 km SW of Clyde Rock road on Mt Ney road, *Hill 2276 & Johnson*, 6 Nov 1986 (NSW, CANB, CBG, MEL, PERTH); 28.8 km NW of Balladonia roadhouse on Highway 1, *Hill 708 & Blaxell*, 14 Nov 1983 (NSW, CANB, PERTH).

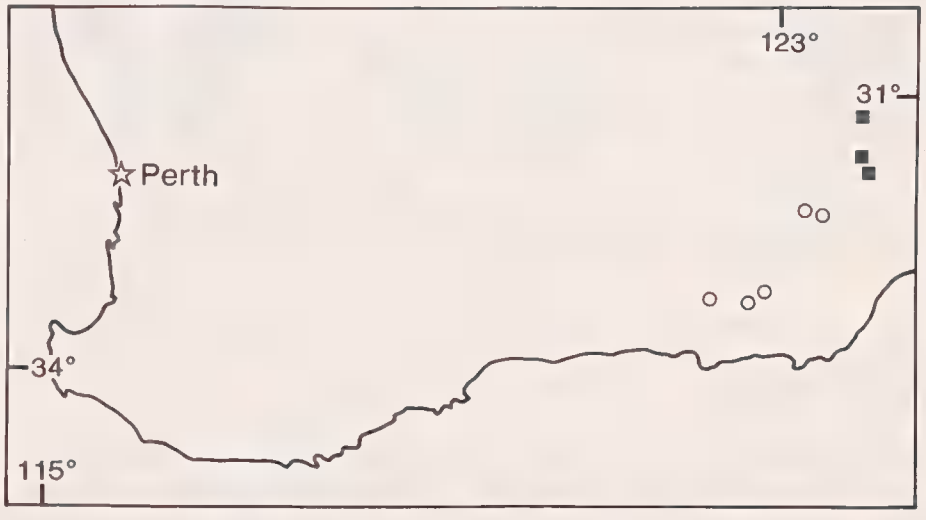

Figure 30. Distribution of *E. balladoniensis* subsp. *balladoniensis* (○) and subsp. *sedens* (■).

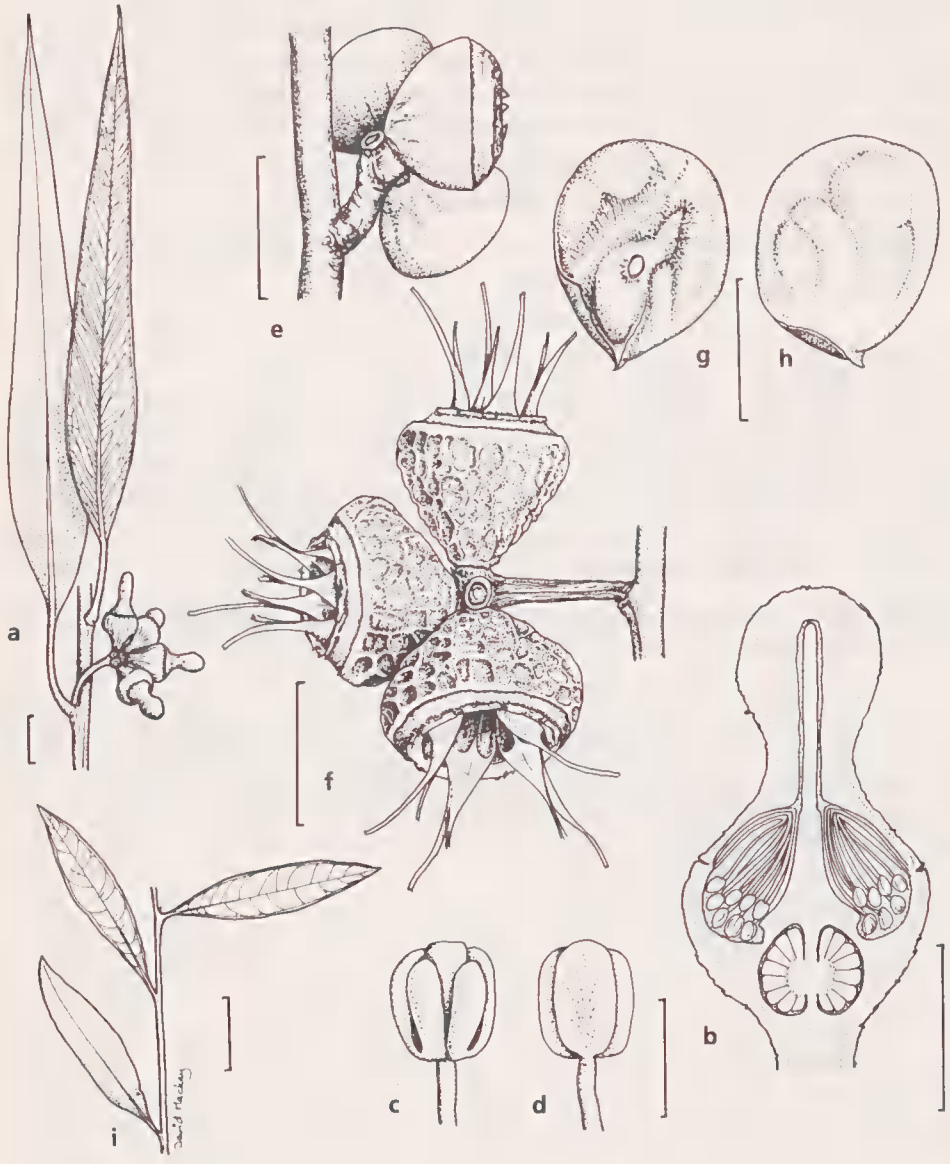

Figure 31. *E. balladoniensis* subsp. *sedens*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, **f**, fruits; **g**, **h**, seed; **i**, juvenile leaves (a, b, c, d, g, h from *Pryor & Briggs 168*, e from *Pryor & Briggs 158*, f from *Pryor & Briggs 163*). Scale bar: a, e, f, i = 1 cm; b = 5 mm; c, d = 0.5 mm; g, h = 1 mm.

26b. Eucalyptus balladoniensis *Brooker* subsp. **sedens** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica alabastris fructibusque subsessilibus et pedunculis crassioribus brevioribusque differt.

Type: Western Australia: 2 km E of Zanthus then 80.6 km S on track to Balladonia, *J.D. Briggs 168 & L.D. Pryor*, 25 Oct 1978 (holo NSW; iso CANB).

Mallee to 6 m. *Bark* persistent for basal 0.5–1.5 m, then smooth, grey. *Adult leaves* 7–12 cm long, 1.2–2.4 cm wide; petioles to 19 mm long. *Peduncles* thick, angular or ± flattened, 6–8 mm long; pedicels ± absent. *Fruits* 8–11 mm long, 9–12 mm diam. Figure 31.

Subspecies *sedens* is distinguished by the subsessile buds and fruits, and the thicker, shorter peduncles.

Subsp. 'sessile fruit' of Brooker & Kleinig (1990).

Distribution: Known only from a few populations south of Zanthus (Coolgardie District). Figure 30.

Ecology: A component of eucalypt woodland on flat, calcareous red sand country with a variety of species, including *E. concinna* Maiden & Blakely, *E. flocktoniae* (Maiden) Maiden, *E. gracilis* F. Muell. and *E. platycorys* Maiden & Blakely, with a *Triodia* understorey.

Conservation status: Not considered to be at risk. Although known from a relatively restricted area, this subspecies is likely to be more abundant than is presently known, and occurs in a very remote locality that is secure from disturbance.

The epithet is from the Latin *sedens*, sitting, referring to the subsessile fruits.

Selected specimens (from 4 examined): Western Australia (N to S): 27.9 km S of turnoff E of Zanthus on Balladonia track, *Hill 2697 & Johnson*, 30 Nov 1986 (NSW), 29 km S of same turnoff, *Pryor & J. Briggs 158*, 24 Oct 1978 (CANB, NSW), 34.8 km S of same turnoff, *Pryor & J. Briggs 163*, 24 Oct 1978 (CANB, NSW).

Series *Macrocarpae*, subseries *Leptopodosae*

Species 27 to 29 are placed in series *Macrocarpae*, which is defined by the combination: pith glands absent; filaments inflexed or irregularly flexed; anthers oblong to ovoid, dorsifixed, versatile, dehiscing by longitudinal slits; seeds ovoid, shallowly reticulately pitted. Within this series, all species discussed here are placed in subseries *Leptopodosae*, defined by the non-thickened calyptra.

27. Eucalyptus leptopoda *Benth.*, Fl. Austral. 3: 238 (1867).

Type citation: 'W. Australia, Drummond, 5th Coll. Suppl. n. 33 and 36, also n. 151 and 188 of other sets.'

Type: *Drummond 5th Coll. Suppl. no. 33* (lecto K; isolecto BM, CGE, E, FI, K, KW, LE, MEL, NSW, PERTH, W). Crisp (1982) established lectotypification, although Mueller (1878) had already excluded Drummond 151 and 188 from *E. leptopoda*, including them in *E. salmonophloia* F. Muell.

[*E. angustifolia* Turcz., Bull. Cl. Phys.-Math. Acad. Soc. Sci. Saint-Petersbourg 10: 337 (1852), nom. illegit.; non Desf. ex Link, Enum. Hort. Berol. 2: 30 (1822)]

Mallee to 2.5 m, less commonly a tree to 7 m. *Bark* smooth, grey, cream or white and pink or brown, shedding in ribbons, sometimes persistent on lower trunk, thick,

shortly fibrous-flaky. *Juvenile leaves* disjunct, linear to lanceolate, to 12 cm long, 10 mm wide. *Adult leaves* dull, grey-green, disjunct, similifacial, linear to lanceolate, 5–14 cm long, 3–17 mm wide; petioles 3–12 mm long; lateral veins irregular, at 25–45° to midrib; intramarginal vein distinct, 0.5–1.5 mm from margin. Inflorescences simple, axillary; umbellasters 7–11(–15)-flowered; peduncles slender, terete, 5–19 mm long; pedicels slender, terete, 3–11 mm long. *Buds* conical, 7–11 mm long, 4–6 mm diam.; hypanthium hemispherical, calyptra conical, sometimes rostrate. *Stamens* all fertile; filaments variously flexed; anthers dorsifixed low on connective gland, versatile, ovoid, dehiscing through short parallel slits. *Fruits* hemispherical to flattened-globular, 5–8 mm long, 6–11 mm diam.; calyptra and stemonophore scars narrow, depressed; disc level to domed; valves 4–5(–6), triangular, acuminate with persistent tips of style, raised. *Seeds* ovoid, dull, deep red-brown, shallowly pitted; hilum ventral.

Four broadly geographic subspecies are recognised.

1 Disc steeply raised in fruit

2 Adult leaves lanceolate ..... **27b.** subsp. **elevata**

2* Adult leaves linear ..... **27c.** subsp. **arctata**

1* Disc flat or rounded in fruit

3 Inflorescences mostly more than 7-flowered; branchlets pruinose ..... **27a.** subsp. **leptopoda**

3* Inflorescences all or mostly 7-flowered; branchlets not or weakly pruinose ..... **27d.** subsp. **subluta**

27a. Eucalyptus leptopoda *Benth.* subsp. **leptopoda**

Branchlets pruinose. *Leaves* narrow-lanceolate to lanceolate (broader in the east of the range), 7–13 cm long, 6–12 mm wide; petioles 6–11 mm long. *Umbellasters* (7–)11(–15)-flowered; peduncles 6–17 mm long; pedicels 4–8 mm long. *Fruits* 6–7 mm long, 7–11 mm wide; disc flat to slightly domed.

Distinguished by the combination: branchlets pruinose; leaves narrow-lanceolate to lanceolate; umbellasters usually more than 7-flowered, often 11- and sometimes to 15-flowered; pedicels slender; fruits small to medium; disc flat to slightly domed. Figure 32.

Large plants may have a short stocking of persistent bark, but this is not as consistent nor well developed as in the north-western subspecies (below). Plants from the north-east of the range (Bullfinch to Bencubbin, collected near Chiddarcooping) show a strikingly pendulous foliage habit.

Distribution: near Tammin and Kellerberrin east to near Southern Cross, extending south to Marble Rocks and north to Chiddarcooping. Figure 33.

Ecology: Usually occurs as scattered plants in low heath on deep sands.

Conservation status: Not considered to be at risk.

Selected specimens (from 12 examined): Western Australia (W to E): 6.4 miles [10.5 km] N of Bungalla turnoff on highway, *Tindale 3716*, 26 Aug 1973 (NSW, AD, CANB, K, PERTH); Trayning district, *Steedman 1*, May 1937 (NSW); Kwelkan, *Steward 148*, 4 May 1917 (NSW); 9.5 miles [16 km] E of Merredin, *Johnson W 127*, 16 Dec 1960 (NSW); 6.8 miles [11 km] E of Carrabin by road, *Coveny 8362 & Habersley*, 12 Sep 1976 (NSW, CANB, K, PERTH); firebreak on W side of Chiddarcooping Nature Reserve, *Hill 2199, Johnson & Blaxell*, 15 Nov 1986 (NSW, PERTH).

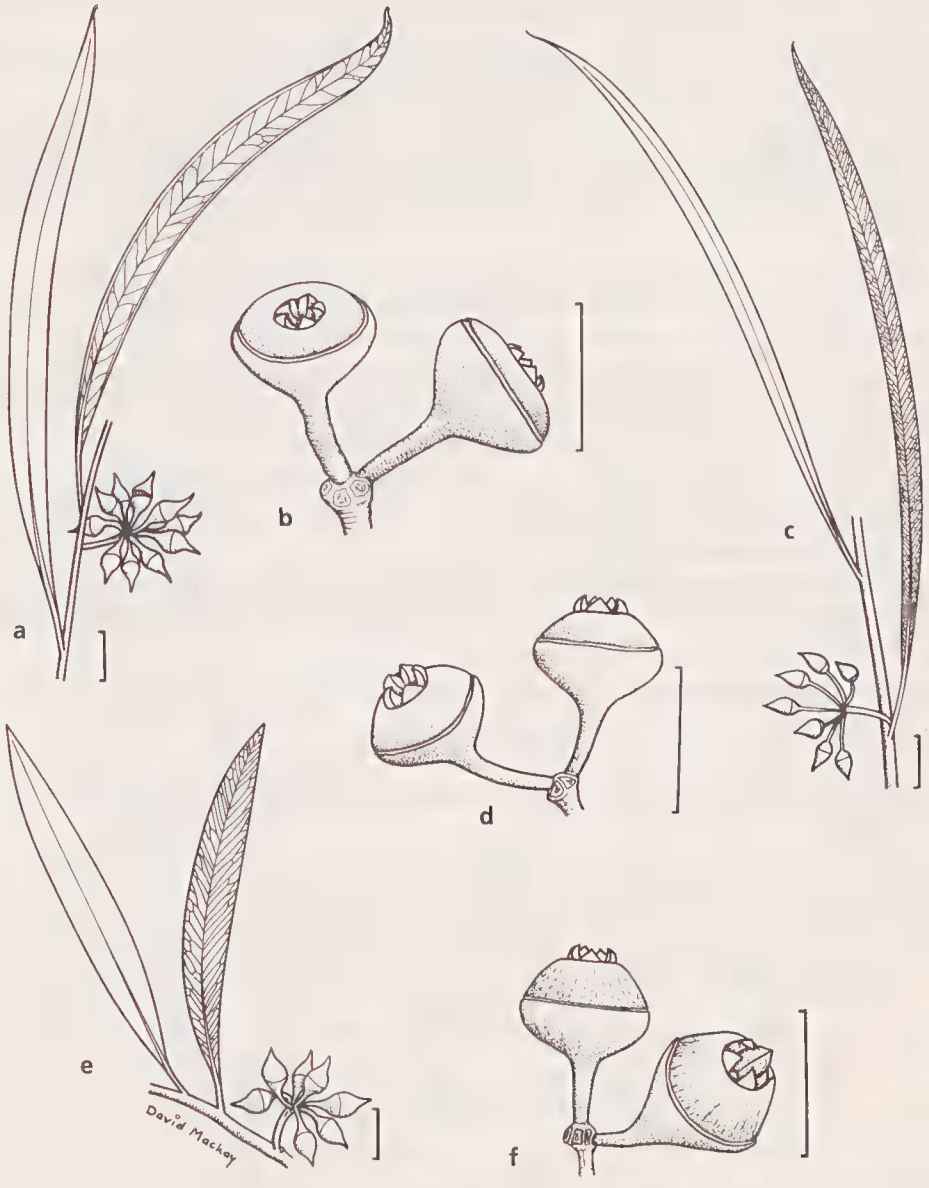

Figure 32. *E. leptopoda* subsp. *leptopoda*. **a**, adult leaves and buds; **b**, fruits (from *Steedman 1*, May 1937). *E. leptopoda* subsp. *arctata*. **c**, adult leaves and buds; **d**, fruits (from *Brooker 7922*). *E. leptopoda* subsp. *elevata*. **e**, adult leaves and buds; **f**, fruits (from *Brooker 7934*). Scale bar = 1 cm.

27b. Eucalyptus leptopoda *Benth.* subsp. **elevata** *L. Johnson & K. Hill*, **sp. nov.**

Inter subspecies *E. leptopodae* combinatione sequenti characterum distinguitur: ramuli non pruinosi; folia lanceolata vel latiora; umbellastrae 7-florae; pedicelli crassi; fructus saepissime mediocres vel magni disco valde elevato.

TYPE: WESTERN AUSTRALIA: 16 km from Wiluna – Agnew road on Yeelirrie road, *M.I.H. Brooker 9247*, 17 Apr 1986 (holo NSW; iso CANB, PERTH).

Branchlets not pruinose. *Leaves* lanceolate to broad-lanceolate, 6–10 cm long, 8–17 mm wide; petioles 8–10 mm long. *Umbellasters* 7-flowered; peduncles 7–13 mm long; pedicels 4–9 mm long. *Fruits* 6–8 mm long, 7–10 mm wide; disc strongly raised. Figure 32.

Distinguished by the combination: branchlets not pruinose; leaves lanceolate or broader; umbellasters 7-flowered; pedicels thick; fruits medium to large; disc strongly domed.

A stocking of persistent ribbony rough bark is commonly found on the lower trunks in taller individuals, chiefly in the western part of the range. Brooker & Kleinig (1990: 419) regard these western forms as a separate subspecies (subsp. *pachyphitra* ined.).

A broad zone of intergradation occurs with subsp. *arctata* in the region between Mullewa and south of Morawa (Figure 33). Hybridisation is also recorded with *E. websteriana* subsp. *websteriana*.

DISTRIBUTION: Locally frequent from Yuna to Morawa and, perhaps with a discontinuity, east to Meekatharra and Wiluna and into the desert almost to 127°E and south to about 29°S. Figure 33.

ECOLOGY: A component of shrub heath on red or yellow sandhill country

CONSERVATION STATUS: Not considered to be at risk.

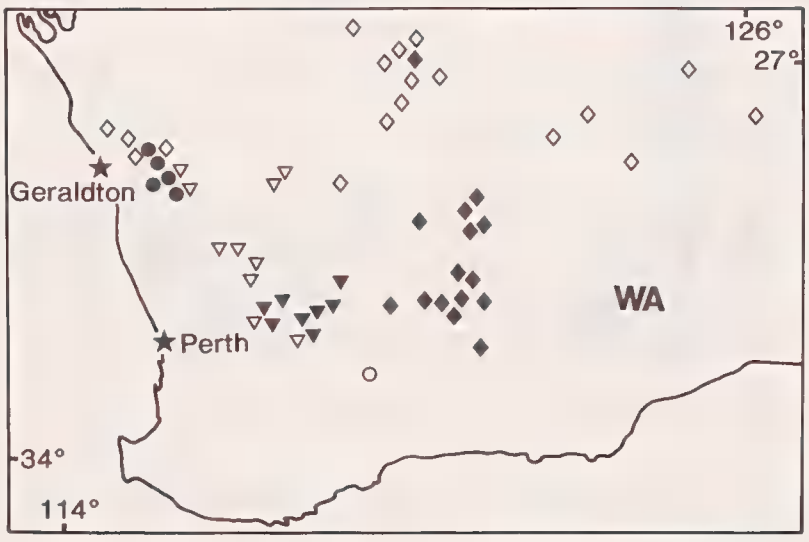

Figure 33. Distribution of *E. leptopoda* subsp. *leptopoda* (▼), *E. leptopoda* subsp. *arctata* (▽), *E. leptopoda* subsp. *elevata* (◇), *E. leptopoda* subsp. *subluta* (◆), *E. leptopoda* subsp. *leptopoda* – subsp. *subluta* intergrade (○) and *E. leptopoda* subsp. *arctata* – subsp. *elevata* intergrades (●).

Selected specimens (from 25 examined): Western Australia (W to E): Horan Road, 5.7 km N of Ogilvie East Road (28°07'S 114°48'E), *Brooker 9934, 9935*, 20 Apr 1988 (CANB, NSW, PERTH); 9.5 km N of Yuna road on Wandara road, *Brooker 7934*, 25 Jan 1983 (CANB, NSW, PERTH); 9.4 miles [16 km] W of Pindar, *Chippendale 48*, 20 Oct 1966 (CANB, NSW); 47.0 km S of Youanmi on Bullfinch road, *Hill 2602 & Johnson*, 25 Nov 1986 (NSW); 64.5 km E of Meekatharra on Wiluna road, *Hill 507, Johnson, Blaxell & Brooker*, 2 Nov 1983 (NSW, CANB, PERTH); 67 km from Wiluna–Agnew road on Sandstone road, *Brooker 8650*, 30 Aug 1984 (CANB, NSW, PERTH); 91.3 km W of Wiluna – Agnew road on Sandstone road, *Brooker 8706*, 17 Oct 1984 (CANB, NSW, PERTH); W of Sandstone road, S of Wiluna, *Speck 858*, 20 Sep 1957 (CANB, NSW); 2.4 km N of Albion Downs turnoff on Leonora – Wiluna road, *Hill 516, Johnson, Blaxell & Brooker*, 3 Nov 1983 (NSW, AD, BRI, CANB, K, MEL, MO, PERTH); 21 km E of Cosmo Newbery, *Brooker 8536*, 9 May 1984 (CANB, NSW, PERTH); 242 km S of Warburton towards Neale Junction, *Brooker 8559*, 11 May 1984 (CANB, NSW, PERTH).

27c. Eucalyptus leptopoda *Benth.* subsp. **arctata** *L. Johnson & K. Hill*, **subsp. nov.**

Inter subspecies *E. leptopodae* combinatione sequenti characterum distinguitur: ramuli non pruinosi; folia linearia vel anguste linearia, erecta; umbellastra 7-flora; pedicelli graciles; fructus parvi vel mediocres, disco modice elevato vel aliquando planato.

Type: Western Australia: 20 km E of Dalwallinu towards Kulja, *M.I.H. Brooker 7922*, 12 Jan 1983 (holo NSW; iso CANB, PERTH).

Branchlets not pruinose. *Leaves* linear to narrow-lanceolate, erect, 7–14 cm long, 3–8 mm wide; petioles 3–7 mm long. *Umbellasters* 7-flowered; peduncles 5–9 mm long; pedicels 3–11 mm long. *Fruits* 5–8 mm long, 6–10 mm wide; disc moderately to strongly domed. Figure 32.

Distinguished by the combination: branchlets not pruinose; leaves linear, erect; umbellasters 7-flowered; pedicels slender; fruits small to medium; disc moderately to strongly domed.

Larger individuals usually show a stocking of persistent bark on the lower trunk, as do western occurrences of subsp. *elevata* (above). The two subspecies also intergrade over a broad zone (above).

Although recent collections of this subspecies are from near Cadoux northwards, two older collections indicate an overlap with subsp. *leptopoda*. If these are indeed partly sympatric, the taxonomic rank will require reconsideration. Recent search by one of us (L.J.) in the Merredin–Bruce Rock area has not confirmed the two early vaguely specified collections cited below.

Distribution: From Koolanooka to Tammin and perhaps south of Merredin, northeast to Paynes Find. Figure 33.

Conservation status: Not considered to be at risk.

The epithet is from the Latin *arctatus*, narrowed, in reference to the narrow leaves.

Selected specimens (from 11 examined): Western Australia (W to E): 4.7 km N of Gutha–Wurarga road on McWhirter Road, *Hill 2579 & Johnson*, 23 Nov 1986 (NSW, PERTH); 44 km NNE of Paynes Find, *Brooker 8713*, 18 Oct 1984 (CANB, NSW); rabbit fence 60 miles [100 km] E of Watheroo, *Koch 1609, 1611*, Oct 1905 (NSW); 10.9 km W of Koorda on Cadoux road, *Hill 2503, Johnson & Blaxell*, 16 Nov 1986 (NSW, PERTH); Tammin, *Maiden*, Oct 1909 (NSW); Bruce Rock, *Stoward 19*, Sep 1916 (NSW).

27d. Eucalyptus leptopoda *Benth.* subsp. **subluta** *L. Johnson & K. Hill*, **subsp. nov.**

Inter subspecies *E. leptopodae* combinatione sequenti characterum distinguitur: ramuli saepissime non vel leviter pruinosi; folia linearia vel anguste linearia, erecti; umbellastrae saepissime 7-florae; pedicelli graciles; fructus parvi vel mediocres, disco planato.

TYPE: WESTERN AUSTRALIA: 37 km SE of Coolgardie, *M.I.H. Brooker 7048*, 9 Nov 1981 (holo NSW; iso CANB, PERTH).

Branchlets usually weakly or not pruinose. *Leaves* linear to lanceolate, 5–9 cm long, 6–12 mm wide; petioles 10–12 mm long. *Umbellasters* usually 7-flowered (rarely some with more flowers); peduncles 8–10 mm long; pedicels 4–6 mm long. *Fruits* 5–7 mm long, 7–10 mm wide; disc flat to slightly domed.

Distinguished by the combination: branchlets weakly or not pruinose; leaves linear to lanceolate, erect; umbellasters usually 7-flowered; pedicels slender; fruits small to medium; disc flattened.

DISTRIBUTION: Apart from an apparent outlier sympatric with subsp. *elevata* south of Wiluna, this subspecies occupies the south-east of the range of the species, from somewhat north of Menzies to north-east of Norseman. Figure 33.

Some intergradation occurs with subsp. *leptopoda* where the ranges meet.

CONSERVATION STATUS: Not considered to be at risk.

The epithet is from the Latin *sublutus*, washed beneath, referring to the usually slighter degree of pruinosity of the branchlets, in contrast to those of subsp. *leptopoda*.

SELECTED SPECIMENS (from 22 examined): WESTERN AUSTRALIA (N to S): 16 km from Wiluna – Agnew road on Yeelirrie road, *Brooker 9248*, 17 Apr 1986 (CANB, NSW, PERTH); 36 km N of Menzies towards Leonora, *Hill 532, Johnson, Blaxell & Brooker*, 4 Nov 1983 (NSW, AD, CANB, PERTH); 4.2 miles [6 km] N of Menzies towards Leonora, *Baker 91*, 8 Nov 1970 (CANB, NSW); 20 miles [32 km] W of Riverina homestead, *Beard 6514*, 11 Sep 1973 (PERTH, NSW); Comet Vale, *Maiden*, Sep–Nov 1909 (NSW); 0.4 km E of gate, Goongarrie Nat. Reserve, *Brooker 9606, 9607, 9608, 9609*, 6 May 1987 (CANB, NSW, PERTH); 60.3 miles [100 km] W of Coolgardie on highway, *Tindale 59 & Bennett*, 9 Mar 1970 (NSW);66 km SSW of Coolgardie on road to Queen Victoria Rock, *Crisp 5603*, 31 Jan 1979 (CBG, NSW, PERTH); 39.1 km W of Coolgardie – Norseman road on Hyden road, *Hill 2852*, 25 Aug 1988 (NSW).

Subsp. *arctata* – subsp. *elevata* intergrades (from 8 examined): 5.6 km S of Geraldton–Mullewa road on Mingenew road, *Hill 2574 & Johnson*, 23 Nov 1986 (NSW, PERTH); 8.5 miles [15 km] S of Morawa, *Chippendale 55*, 20 Oct 1966 (CANB, NSW).

Subsp. *leptopoda* – subsp. *subluta* intergrades: c. 50 km E of Hyden, 1 km N of Marble Rocks, *Crisp 5549*, 29 Jan 1979 (CBG, CANB, NSW, PERTH).

E. leptopoda* subsp. *elevata* x *E. websteriana* subsp. *websteriana: 91 km NW of airstrip SE of Lake Rason (28°54'S 124°29'E), *Brooker 8574*, 13 May 1984 (CANB, NSW, PERTH).

28. Eucalyptus synandra *Crisp*, Nuytsia 4(1): 129 (1982).

TYPE CITATION: '*Typus*: ± 5 km S of Jingymia, 30°31'S, 117°25'E, 2 Jan. 1981, *A.S. George* 16203, fl., fr., photo, spirit material (holo : PERTH; iso : CBG, FRI [now CANB], K, NSW, PERTH).'

Mallee to 5 m. *Bark* smooth, powdery white over pink and brown, shedding in ribbons. *Juvenile leaves* opposite, lanceolate for about 4 nodes, becoming linear, disjunct, to 8 cm long, 3 mm wide. *Adult crown* thin, pendulous. *Adult leaves* dull, grey-green, disjunct, similifacial, linear to narrow-lanceolate, 6–18 cm long, 6–15 mm wide; petioles 3–15 mm long; lateral veins irregular, at 25–45° to midrib; intramarginal vein distinct, 0.5–1.5 mm from margin. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles slender, terete, 9–18 mm long; pedicels slender, terete, 7–16 mm long. *Buds* conical, 16–24 mm long, 7–8 mm diam.; hypanthium shallowly hemispherical to saucer-shaped, calyptra conical, attenuate. *Stamens* all fertile; filaments variously flexed, cream to pink, united for lower half into a tube; anthers dorsifixed, versatile, ovoid,

dehiscing through short parallel slits. *Fruits* hemispherical to flattened-globular, 6–9 mm long, 9–13 mm diam.; calyptra and stemonophore scars narrow, depressed; disc domed; valves triangular, acuminate with persistent tips of style, raised. *Seeds* ovoid, dull, deep red-brown, shallowly pitted; hilum ventral.

E. synandra is described here under a reduced circumscription to allow comparison with the segregate taxon described below. Both taxa are distinguished within the subseries by the partially coherent filaments. The related *E. beardiana* also has partially coherent filaments, and can be distinguished by the elongate cup-shaped hypanthium in bud and fruit, and the longer fruits (9–11 mm long).

Distribution: A rare and localised species of the northeastern Wheat Belt, from near Morawa to near Koorda. Figure 34.

Ecology: This species occurs mostly on shallow sandy soils over gravelly or lateritic rises, in open mallee shrubland with few other eucalypt species.

Conservation status: 3R-. This species is highly localised in distribution, and occurs in country potentially threatened by agricultural activities.

Selected specimens (from 8 examined): Western Australia (W to E): 3.5 km N of Gutha–Wurarga road on McWhirter Road, *Hill 2577 & Johnson*, 23 Nov 1986 (NSW, CANB, CBG, MEL, PERTH); 27 km from Bimbijy Road on Emu Fence Road, *Hill 2515, Johnson & Blaxell*, 16 Nov 1986 (NSW, CANB, CBG, MEL, PERTH).

29. Eucalyptus rosacea *L. Johnson & K. Hill*, **sp. nov.**

Affinis *E. synandrae* sed characteribus sequentibus distinguitur: folia adulta minora, haud pendula; discus minus elevatus; cortex griseus vel roseus.

Type: Western Australia: 12.0 km S of Queen Victoria Spring on Cundeelee road, *K.D. Hill 2686 & L.A.S. Johnson*, 30 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

[*E. elachyphylla* Brooker & Kleinig, Field Guide Eucalypts 2: 419 (1990); nom. illegit.]

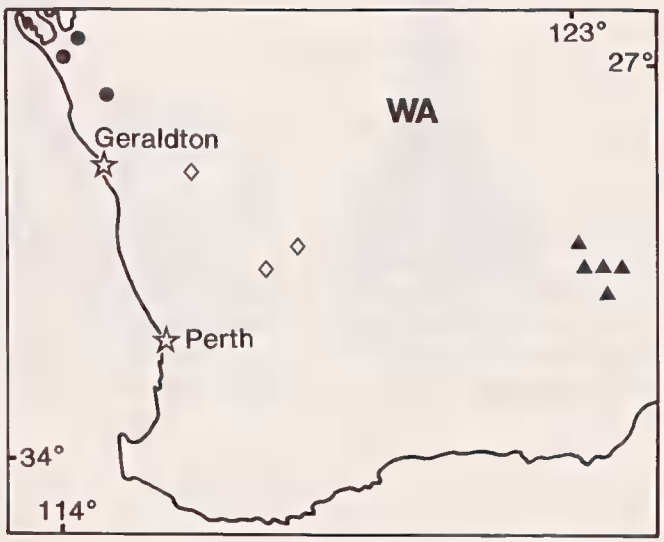

Figure 34. *E. beardiana* (●), *E. synandra* (◇) and *E. rosacea* (▲).

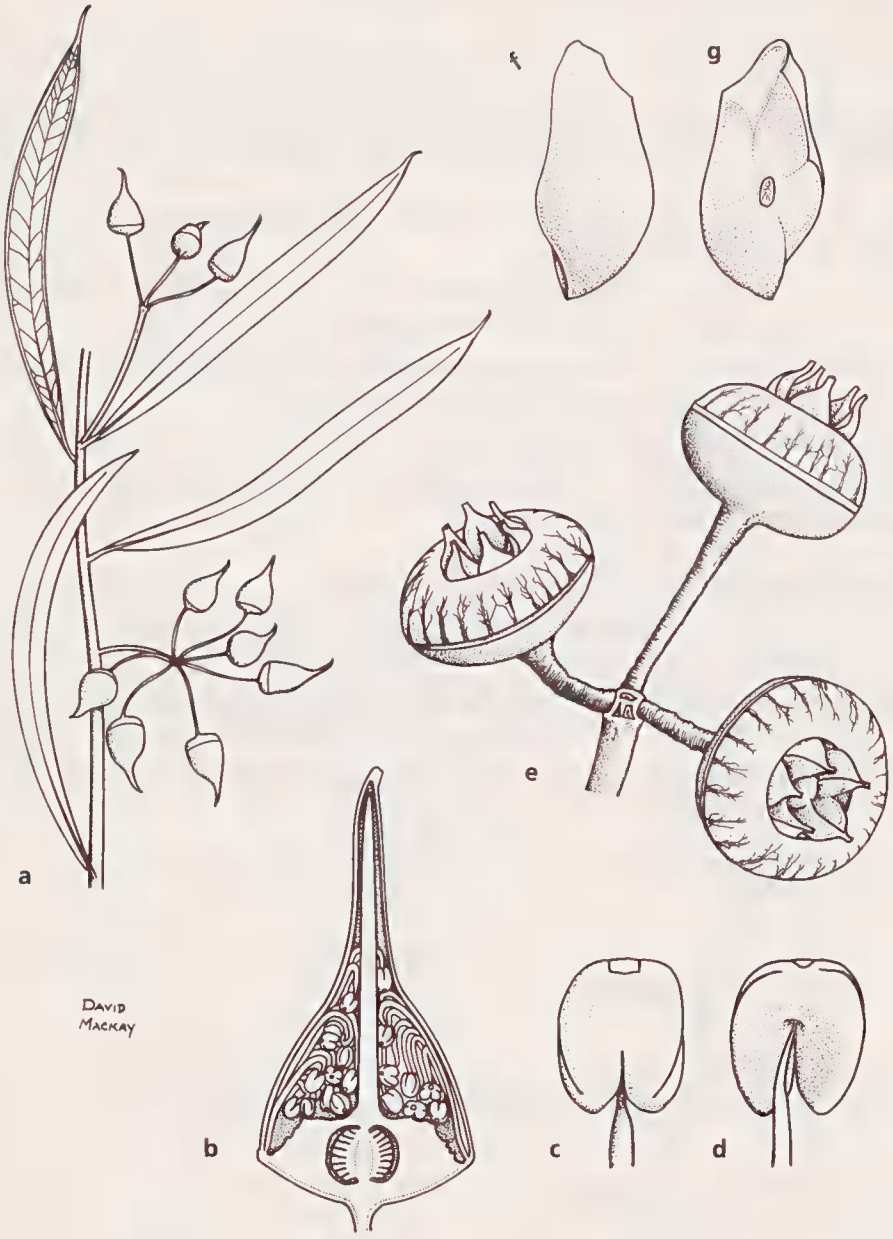

Figure 35. *E. rosacea*. **a**, adult leaves and buds; **b**, section of bud; **c**, **d**, anther; **e**, fruits; **f**, **g**, seed (all from *MacFarlane 1127 & Bedford*). Scale bar: a = 1 cm; b, e = 5 mm; c, d, f, g = 0.5 mm.

Mallee to 2.5 m. *Bark* smooth, grey, white and pink, shedding in ribbons. *Juvenile leaves* opposite, lanceolate for about 6 nodes, becoming linear, disjunct, to 8 cm long, 3 mm wide. *Adult leaves* dull, grey-green, disjunct, similifacial, linear to narrow-lanceolate, 6–12 cm long, 6–10 mm wide; petioles 3–10 mm long; lateral veins irregular, at 25–45° to midrib; intramarginal vein distinct, 0.5–1.5 mm from margin. Inflorescences simple, axillary; umbellasters 3–7-flowered; peduncles slender, terete, 10–20 mm long; pedicels slender, terete, 9–16 mm long. *Buds* conical, 16–20 mm long, 7–8 mm diam.; hypanthium shallowly hemispherical to saucer-shaped, calyptra conical, attenuate. *Stamens* all fertile; filaments variously flexed, cream or pink to red, united for lower half into a tube; anthers dorsifixed, versatile, ovoid, dehiscing through short parallel slits. *Fruits* hemispherical to flattened-globular, 6–9 mm long, 9–13 mm diam.; calyptra and stemonophore scars narrow, depressed; disc slightly raised to domed; valves triangular, acuminate with persistent tips of style, raised. *Seeds* ovoid, dull, deep red-brown, shallowly pitted; hilum ventral. Figure 35.

Distinguished from *E. synandra* (with which it shares the partially united stamen filaments) by the mostly smaller, non-pendulous adult leaves, the less raised disc, and the grey or pink bark (rather than powdery white).

Distribution: Known from the south-western fringes of the Great Victoria Desert. Figure 34.

Ecology: Locally frequent to dominant in low open mallee shrubland on shallow aeolian sands over siliceous substrates.

Conservation status: At least locally, and probably more widely, abundant in a remote area – not considered to be at risk.

The epithet is from the Latin *rosaceus*, rosy, referring to the frequently pink flowers and pinkish bark.

Selected specimens (from 6 examined): Western Australia (W to E): 33.7 km E of Pinjin on PNC road, *Hill 2667 & Johnson*, 29 Nov 1986 (NSW); 12.2 km S of Queen Victoria Spring on Cundeelee road, *Macfarlane 1127 & Bedford*, 2 Dec 1982 (PERTH, NSW); 1.3 km N of Zanthus, *Hill 2693 & Johnson*, 30 Nov 1986 (NSW).

Series *Orbifoliae*

Species 30 to 33 are placed in series *Orbifoliae*, defined by the combination: pith glands absent; bark longitudinally splitting and peeling ('minniritchi' bark, see Brooker & Kleinig 1990); filaments inflexed or irregularly flexed; anthers ovoid, dorsifixed, versatile, dehiscing by short slits; seeds ovoid, shallowly reticulately pitted. The following four species constitute superspecies *Orbifolia*, defined by the obovate, rounded to retuse adult leaves. The early juvenile leaves are lanceolate to ovate, quickly becoming orbicular, and becoming retuse only at a later ontogenetic stage. This suggests that the retuse adult leaves are not merely neotenous (cf. Brooker & Kleinig 1990: 279). The group consists of small isolated occurrences on rocky sites, and minor differences often exist between populations. However, the populations group into consistent assemblages mostly over large total areas, and four species are distinguishable (Figure 37).

Key to the species of superspecies *Orbifolia*

1 Calyptra rounded

2 Fruits more than 7 mm long; branchlets strongly pruinose; buds and fruits strongly pruinose ..... **33. E. orbifolia**

2* Fruits less than 7 mm long; branchlets, buds and fruits weakly or not pruinose ..... **30. E. websteriana**

1* Calyptra conical

3 Calyptra more than 3 times longer than hypanthium; leaves mostly longer than broad ..... **31. E. educta**

3* Calyptra less than 2.5 times longer than hypanthium; leaves broader than long ..... **32. E. lata**

30. Eucalyptus websteriana *Maiden*, J. & Proc. Roy. Soc. New South Wales 49: 313 (1915).

TYPE CITATION: 'Habitat – Near Coolgardie, Western Australia associated with *E. torquata* Luehmann. (Mr. now Dr. C.L. Webster).'

TYPE: WESTERN AUSTRALIA: Coolgardie, *L.C. Webster*, 1900 (lecto NSW, here designated). Three specimens in NSW, collected by Webster from Coolgardie in 1898 (forwarded by C. Walter), 1899 and 1900 may be regarded as syntypes. All three have 'Type' labels affixed by Blakely. However, the 1900 collection is the most comprehensive of the three and we therefore designate it the Lectotype. The collector was wrongly cited as 'C.L. Webster' in the protologue.

Mallee to 3 m, of twisted and spreading habit. *Bark* red-brown, splitting longitudinally and peeling partly back to reveal green to brown smooth bark ('minniritchi' bark). *Branchlets* weakly or not pruinose. *Juvenile leaves* disjunct, petiolate, ovate to orbicular. *Adult leaves* disjunct, dull, grey-green, obovate to orbicular, retuse or rounded, 1.5–4.0 cm long, 15–30 mm wide; petioles 10–15 mm long; lateral veins regular, moderately spaced, at 40–50° to midrib; intramarginal vein distinct, more or less looped, 1–3 mm from margin; oil glands angular. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles 8–17 mm long; pedicels 3–8 mm long. *Buds* globular to ovoid, 5–8 mm long, 5–6 mm diam.; calyptra hemispherical, as long as hypanthium or slightly longer. *Stamens* all fertile; filaments slender, irregularly flexed; anthers ovoid, dorsifixed near base of connective gland, versatile, dehiscing through lateral pores. *Fruits* hemispherical to flattened hemispherical, 5–8 mm long, 8–11(–13) mm diam.; calyptra and stemonophore scars raised at c. 45°; disc flat to slightly raised, 2.5–3.5 mm wide. *Seeds* grey-brown, ovoid, shallowly regularly pitted; chaff red-brown.

Distinguished within the superspecies *Orbifolia* by the following combination of characters: adult leaves longer than broad, rounded or retuse; pedicels medium to long (> 3 mm long); calyptra hemispherical; fruits small to medium (< 11 mm diam.); disc slightly swollen; hypanthium bowl-shaped.

Two geographic subspecies are recognised.

1 Branchlets, buds and fruits distinctly pruinose (except when much weathered); pedicels mostly > 5 mm long ..... **30a.** subsp. **websteriana**

1* Branchlets and buds not pruinose except in very young stages; pedicels mostly < 6 mm long ..... **30b.** subsp. **norsemanica**

30a. Eucalyptus websteriana *Maiden* subsp. **websteriana**

Branches, buds and fruits (except when old) distinctly pruinose. *Adult leaves* broad (l:b = 1–1.5:1), retuse or rounded, 1.5–4.0 cm long, 15–30 mm wide; petioles 8–15 mm long. *Pedicels* 5–8 mm long. Figure 36.

Hybrids are recorded with *E. leptopoda* subsp. *elevata* (cited under the latter).

Distribution: Sporadic but locally frequent from Coolgardie and Kambalda east to Plumridge Lakes. Figure 37.

Ecology: Found in scleromorphic shrublands on shallow soil on rocky rises.

Conservation status: 3R. Scattered and localised, although probably not under immediate threat.

Selected specimens (from 12 examined): Western Australia (W to E): Comet Hill, 11.9 km S ofCoolgardie, *Hill 2633 & Johnson*, 26 Nov 1986 (NSW, PERTH); Red Hill, Kambalda, *Coveny 8430 & Habersley*, 14 Sep 1976 (NSW, BRI, CANB, K, L, MEL, PERTH); E slope of Yowie Hill on Pinjin road, *Hill 2663 & Johnson*, 29 Nov 1986 (NSW, PERTH); SE of Lake Rason (28°54'S 124°29'E), *Brooker 8576*, 13 May 1984 (CANB, NSW, PERTH).

30b. Eucalyptus websteriana *Maiden* subsp. **norsemanica** *L. Johnson & K. Hill*, **subsp. nov.**

Ab subspecie typica ramulis alabastris et fructibus maturis non pruinosis, foliis adultis aliquanto angustioribus retusisque et petiolis pedicellisque brevibus differt.

Type: Western Australia: 5.5 miles [8.5 km] N of Norseman, *L.A.S. Johnson W 176*, 18 Dec 1960 (holo NSW 53307; iso PERTH).

Mature branchlets, buds and fruits not pruinose. *Adult leaves* narrowish, mostly retuse, 2.2–4.0 cm long, 14–21 mm wide; petioles 7–11 mm long. *Pedicels* 3–6 mm long. Figure 36.

Distinguished from subsp. *websteriana* by the non-pruinose mature branchlets, buds and fruits, the somewhat narrower, retuse adult leaves, and the often shorter petioles and pedicels.

Distribution: Known from a single stand on skeletal soil on a granite outcrop north of Norseman, but an isolated population near Widgiemooltha shows intermediate characters (see below). Figure 37.

Conservation status: 2V-. Known only from the type locality, which is possibly at risk from mineral exploration and mining activities.

The epithet refers to the town of Norseman, near the type locality.

Selected specimens (from 7 examined): Western Australia: 8 km N of Norseman, *Hill 591, Johnson, Blaxell, Brooker & Hopper*, 6 Nov 1983 (NSW); 5.7 miles [9.1 km] N of Norseman, *Brooker 4537*, 11 Apr 1974 (CANB, NSW, PERTH).

Intergrades, subsp. *websteriana* – subsp. *norsemanica*: Lake Lefroy, *Larsen*, Sep 1920 (NSW).

31. Eucalyptus educta *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. orbifoliae* calyptra longa conicaque distinguitur.

Type: Western Australia: The Dromedaries, north of Beacon, *M.I.H. Brooker 8436*, 25 Jan 1984 (holo NSW; iso AD, CANB, MEL, PERTH).

Figure 36. *E. websteriana* subsp. *websteriana*. **a**, adult leaves and buds; **b**, fruits (from *Coveny 8430 & Habersley*). *E. websteriana* subsp. *norsemanica*. **c**, adult leaves and buds; **d**, fruits (**c** from *Brooker 4537*, **d**, from *NSW 53307*). *E. educta*. **e**, adult leaves and buds; **f**, fruits (**e** from *Brooker 8494*, **f** from *Brooker 8436*). *E. lata*. **g**, adult leaves and buds; **h**, fruits (**g** from *Cooper*, June 1923, **h** from *Fraser*, 24 Feb 1922). *E. orbifolia*. **i**, adult leaves and buds; **j**, fruits (from *Brooker 5114*). Scale bars = 1 cm.

Mallee to 3 m, of twisted and spreading habit. *Bark* red-brown, splitting longitudinally and peeling partly back to reveal green to brown smooth bark ('minniritchi'). Branchlets glaucous. *Juvenile leaves* disjunct, petiolate, ovate to orbicular. *Adult leaves* disjunct, dull, grey-green to strongly glaucous, obovate to orbicular, usually rounded (mostly not retuse), 2.0–4.0 cm long, 15–30 mm wide; petioles 5–8 mm long; lateral veins regular, moderately spaced, at 40–50° to midrib; intramarginal vein distinct, more or less looped, 1–3 mm from margin; oil glands angular. *Inflorescences* simple, axillary; umbellasters 7-flowered; peduncles 9–14 mm long; pedicels 6–8 mm long. *Buds* ovoid to fusiform, 15–18 mm long, 5–6 mm diam.; calyptra elongate-conical, more than 3 times as long as hypanthium. *Stamens* all fertile; filaments slender, irregularly flexed and erect; anthers ovoid, dorsifixed near base of connective gland, versatile, dehiscing through lateral pores. *Fruits* hemispherical to flattened hemispherical, 6–7 mm long, 9–10 mm diam.; calyptra and stemonophore scars raised at c. 45°; disc flat to slightly raised, 2.5–3.5 mm wide. *Seeds* grey-brown, ovoid, shallowly regularly pitted; chaff red-brown. Figure 36.

Distinguished within the *E. orbifolia* group by the long, conical calyptra, and longer leaves.

Distribution: Known only from The Dromedaries. Figure 37.

Ecology: Restricted to scleromorphic shrubland on shallow gritty sand over granite.

Conservation status: 2R-. Known only from the type locality, which is in a remote and relatively undisturbed area.

The epithet is from the Latin *eductus*, drawn out, referring to the long calyptra.

Specimens examined: Western Australia: Gillian Rock, N of Beacon, *Hill 2512, Johnson & Blaxell*, 16 Nov 1986 (NSW, PERTH); *Brooker 8494*, 16 Mar 1984 (CANB, NSW, PERTH).

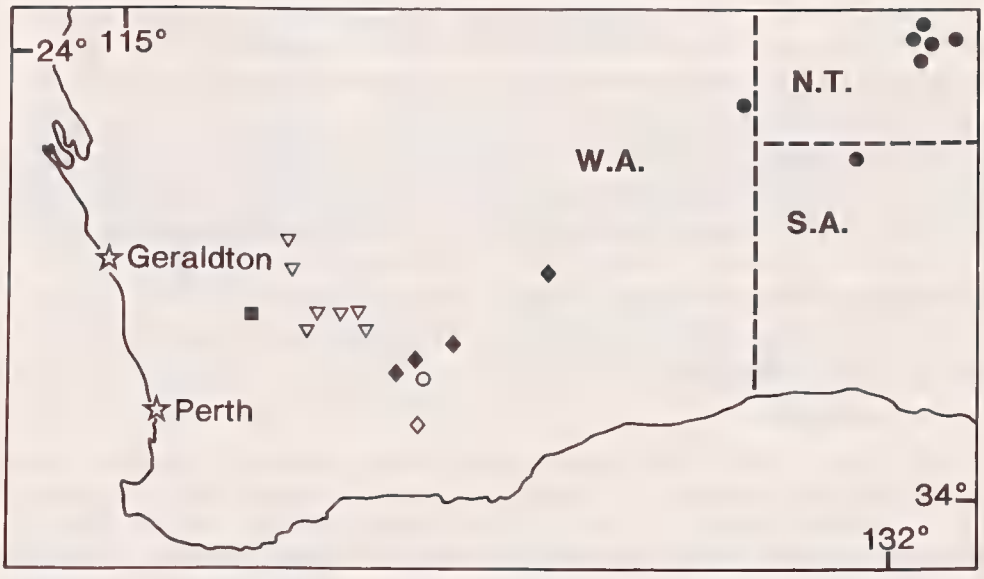

Figure 37. Distribution of *E. websteriana* subsp. *websteriana* (◆), subsp. *norsemanica* (◇), subsp. *websteriana* – subsp. *norsemanica* intergrades (○), *E. lata* (▽), *E. educta* (■) and *E. orbifolia* (●).

32. Eucalyptus lata *L. Johnson & K. Hill*, **sp. nov.**

Inter species affinitatis *E. orbifoliae* combinatione sequenti characterum distinguitur: folia adulta lata, pedicelli breves, calyptra breviter conica, et fructus magni.

TYPE: WESTERN AUSTRALIA: 13.6 km W of Callion on Mussons Soak road, *K.D. Hill 2658 & L.A.S. Johnson*, 28 Nov 1986 (holo NSW; iso CANB, CBG, MEL, PERTH).

Mallee to 3 m, of twisted and spreading habit. *Bark* red-brown, splitting longitudinally and peeling partly back to reveal green to brown smooth bark ('minniritchi' bark). *Branchlets* strongly glaucous. Juvenile leaves disjunct, petiolate, ovate to orbicular. *Adult leaves* disjunct, dull, grey-green, orbicular, regularly retuse, 2.5–5.0 cm long, 25–50 mm wide; petioles 8–27 mm long; lateral veins regular, moderately spaced, at 40–50° to midrib; intramarginal vein distinct, more or less looped, 1–4 mm from margin; oil glands angular. Inflorescences simple, axillary; umbellasters 7-flowered; peduncles 5–29 mm long; pedicels 3–6 mm long. *Buds* ovoid, 10–12 mm long, 8–9 mm diam.; calyptra broadly conical, 1.5–2.5 times as long as hypanthium. *Stamens* all fertile; filaments slender, irregularly flexed and erect; anthers ovoid, dorsifixed near base of connective gland, versatile, dehiscing through lateral pores. *Fruits* flattened obconical, 7–9 mm long, 13–15 mm diam.; calyptra and stemonophore scars raised at c. 45°; disc flat, 3–5 mm wide. *Seeds* grey-brown, ovoid, shallowly regularly pitted; chaff red-brown. Figure 36.

Distinguished within the *E. orbifolia* group by the broad adult leaves with medium to long petioles, the shortly conical calyptra, and the large fruits with short, thick pedicels.

DISTRIBUTION: Sporadic and localised, from near Youanmi to the Die Hardy Range, and east to near Callion. Figure 37.

ECOLOGY: Restricted to scleromorphic shrublands on shallow sandy soil over granite rocks

CONSERVATION STATUS: Although populations are highly localised, the species is widely scattered over relatively undisturbed country, and not considered to be at risk.

The epithet is from the Latin *latus*, broad, referring to the leaves and fruits.

SELECTED SPECIMENS (from 9 examined): WESTERN AUSTRALIA (W to E): 23.0 km SW of Youanmi on Paynes Find road, *Hill 2594 & Johnson*, 24 Nov 1986 (NSW, PERTH); Mt Jackson to Lake Barlee, *Fraser*, 24 Feb 1922 (NSW); Pigeon Rock, 89.7 miles [143 km] N of Bullfinch, *Chippendale 358*, 21 Mar 1968 (CANB, NSW); 3.5–4 miles [5.6–6.4 km] W of Lake Giles, *Cooper*, 27 June 1923 (NSW); Hospital Rock, 30 miles [50 km] W of Riverina, *Beard 6519*, 11 Sep 1973 (PERTH, NSW).

33. Eucalyptus orbifolia *F. Muell.*, Fragm. 5: 50 (1865).

TYPE CITATION: 'Ad bases montium graniticorum Novae Hollandiae austro-occidentalis interioris, longitudine 119°25', latitudine 30°47'. C. Harper.'

TYPE: holo MEL; iso K.

Mallee to 3 m, of twisted and spreading habit. *Bark* red-brown, splitting longitudinally and peeling partly back to reveal green to brown smooth bark ('minniritchi' bark). *Branchlets* strongly glaucous. Juvenile leaves disjunct, petiolate, ovate to orbicular, later ones retuse. *Adult leaves* disjunct, dull, strongly glaucous, obovate to orbicular, usually longer than broad, regularly retuse, 2.0–4.5 cm long, 15–40 mm wide; petioles 6–16 mm long; lateral veins regular, moderately spaced, at 40–50° to midrib; intramarginal vein distinct, more or less looped, 1–3 mm from margin; oil glands angular. Inflorescences simple, axillary; umbellasters 7-flowered or rarely 3-flowered; peduncles 8–20 mm long; pedicels 4–10 mm long. *Buds* globular to ovoid,

8–10 mm long, 6–8 mm diam.; calyptra hemispherical, as long as hypanthium or slightly longer. *Stamens* all fertile; filaments slender, irregularly flexed; anthers ovoid, dorsifixed near base of connective gland, versatile, dehiscing through lateral pores. *Fruits* hemispherical to flattened hemispherical, 7–9 mm long, 8–13 mm diam.; calyptra and stemonophore scars raised at c. 45°; disc flat to slightly raised, 3–4 mm wide. *Seeds* grey-brown, ovoid, shallowly regularly pitted; chaff red-brown. Figure 36.

E. orbifolia is described here under a reduced circumscription to allow comparison with segregate taxa described above.

Distribution: Sporadic but locally frequent, in ranges of Central Australia; recorded from the Dean Range (Western Australia), Musgrave Range (South Australia) and MacDonnell Range (Northern Territory). Figure 37.

Ecology: Restricted to shallow or skeletal sandy soils on the higher slopes of sandstone ranges.

Hybrids are recorded with *E. sessilis* (Maiden) Blakely.

Conservation status: Widely scattered over relatively undisturbed country, not considered to be at risk.

Selected specimens (from 12 examined): Western Australia: S end of Dean Range, *Carolin 6106*, 2 Aug 1967 (NSW). South Australia: upper slopes of Mt Woodroffe, *Symon 2693*, 11 Aug 1962 (AD, NSW). Northern Territory (W to E): Mt Sonder, *Dunlop 2513*, 20 Apr 1972 (DNA, NSW); track to Palm Valley No. 2 gas well, on crest of Krichauff Ra. W of Mt Hermannsburg, *Hill 865, 866, Johnson & Benson*, 11 July 1984 (NSW), *Brooker 5114*, 5 Apr 1976 (CANB, NSW, PERTH); Serpentine Gorge, *Maconochie 1063*, 1 July 1970 (DNA, NSW).

***E. orbifolia* x *E. sessilis*:** Northern Territory: Palm Valley No. 2 gas well, on crest of Krichauff Ra W of Mt Hermannsburg, *Hill 867, Johnson & Benson*, 11 July 1984 (NSW); Serpentine Gorge, *Maconochie 1065*, 1 July 1970 (DNA, NSW).

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Our colleague in the overall project, Don Blaxell, has contributed helpful discussions on many points and has been involved in the recognition of several of the taxa. Particular thanks are due to Leonie Stanberg, who has provided invaluable assistance through the project and drafted the distribution maps. David Mackay prepared most of the illustrations, and Bob Roden prepared the illustration of *E. mannensis* subsp. *vespertina*. Lani Retter provided much assistance in earlier stages of the investigations. The work was in part supported by grants from the Australian Biological Resources Study and the Royal Botanic Gardens and Domain Trust, which are gratefully acknowledged. A grant from the Royal Botanic Gardens and National Herbarium Research Fund to one of us (LJ) to defray field expenses is also gratefully acknowledged. Dr Surrey Jacobs is thanked for critically reading and commenting on the manuscript. We are grateful to Ian Brooker for useful critical comments.

References

Bentham, G. (1867) *Flora Australiensis*, vol. 3 (L. Reeve: London).

Blakely, W.F. (1934) *A Key to the Eucalypts* (The Worker Trustees: Sydney).

Briggs, J.D. & Leigh, J.H. (1988) *Rare or Threatened Australian Plants*. Australian National Parks and Wildlife Service, Special Publication 14.

Brooker, M.I.H. & Hopper, S.D. (1991) A taxonomic revision of *Eucalyptus wandoo, E. redunca* and allied species (*Eucalyptus* series *Levispermae* Maiden – Myrtaceae) in Western Australia. *Nuytsia* 8(1): 1–189.

Brooker, M.I.H. & Kleinig, D.A. (1990) *Field Guide to Eucalypts* vol 2. (Inkata: Melbourne).

Chippendale, G.M. (1973) *Eucalypts of the Western Australian goldfields* (Australian Government Publishing Service: Canberra).

Chippendale, G.M. (1988) *Eucalyptus, Angophora*. In A.S. George (ed.), *Flora of Australia*, vol. 19 (Australian Government Publishing Service: Canberra).

Crisp, M.D. (1982) *Eucalyptus synandra* (Myrtaceae), a new species of mallee from Western Australia. *Nuytsia* 4(1): 129–134.

Diels, L. & E. Pritzel (1905) Fragmenta phytographiae Australiae occidentalis. *Bot. Jahrb. Syst.* 35: 55–662.

Gardner, C.A. (1960) Trees of Western Australia. *J. Agric. Western Australia* 4th series 1(7): 643–653.

Hall, N. & Johnston, R.D. (1964) *A card key for the identification of eucalypts* (Forestry & Timber Bureau: Canberra)

Johnson, L.A.S. (1972) Evolution and classification in *Eucalyptus*. *Proc. Linn. Soc. New South Wales* 97: 11–29.

Johnson, L.A.S. & Briggs, B.G. (1984) Myrtales and Myrtaceae – a phylogenetic analysis. *Ann. Missouri Bot. Gard.* 71: 700–756.

Johnson, L.A.S. & Hill, K.D. (1990) New taxa and combinations in *Eucalyptus* (Myrtaceae). *Telopea* 4(1): 37–108.

Johnson, L.A.S. & Hill, K.D. (1991) Systematic studies in the eucalypts 2. A revision of the gimlets and related species, *Eucalyptus* extracodical series *Salubres* and *Annulatae* (Myrtaceae). *Telopea* 4(2): 201–222.

Ladiges, P.Y. (1984) A comparative study of trichomes in *Angophora* Cav. and *Eucalyptus* L'Hérit. *Austral. J. Bot.* 32: 561–574

Luehmann, J.G. (1898) A short dichotomous key to the hitherto known species of *Eucalyptus*. *Proc. Austral. Assoc. Adv. Sci.* 7: 523–536.

Maiden, J.H. (1903–33) *A Critical Revision of the Genus Eucalyptus* (Govt. Printer: Sydney).

McVaugh, R. (1968) The Genera of American Myrtaceae – an interim report. *Taxon* 17: 354–418.

Mueller, F. (1878) *Fragmenta phytographiae Australiae* 11: 11–12 (Govt. Printer: Melbourne)

Pryor, L.D. & Johnson, L.A.S. (1971) *A Classification of the Eucalypts* (ANU Press: Canberra).

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New species, lectotypes and synonyms of Australasian *Nymphaea* (Nymphaeaceae)

S.W.L. Jacobs

Abstract

Jacobs, S.W.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000) 1991. New species, lectotypes and synonyms of Australasian Nymphaea *(Nymphaeaceae).* Telopea *4(4): 635-641.* As a precursor to the forthcoming treatment of Nymphaeaceae for the 'Flora of Australia', *Nymphaea elleniae, N. atrans, N. immutabilis* and *N. immutabilis* subsp. *kimberleyensis* are described as new taxa; lectotypes are chosen for *N. violacea* and some of its synonyms, namely *N. violacea* var. *caerulea, N. holtzei, N. rehneltiana* and *N. casparyi; N. dictyophlebia* is placed as a synonym under *N. macrosperma;* and some other names are discussed.

Introduction

The following descriptions, lectotypifications, and discussion are provided as precursors to the treatment of Nymphaeaceae for the 'Flora of Australia'. Only those aspects necessary for that treatment are discussed here; it is planned to produce a fuller account on other aspects soon. This fuller account will include scanning electron micrographs of the seeds of at least all the native species.

New species

Nymphaea elleniae *S.W.L. Jacobs,* **sp. nov.**

N. violaceae affinis sed filamentis antherarum brevioribus, sepalis brevioribus, floribus semper candidis, floribus foliisque plerumque minoribus, differt.

TYPE: QUEENSLAND: Jardine River, 11° 09' S 142° 20' E, *S. Jacobs 5450 & J. Clarkson,* 6 Aug 1987 (holo NSW; iso BRI).

Perennial with vertical elongated rhizome. Juvenile submerged leaf blades often retained for several years, sagittate, usually red; mature blade to 22 cm long, 18 cm wide, undersurface often red, especially toward the margin, margins entire to slightly sinuate. Flowers to 20 cm above the water surface. Sepals 4, to 7 cm long, green outside with purple flecks; margins membranous, white; tip acute or occasionally obtuse. Petals to 25, grading into the stamens, lanceolate, white; tip acute to obtuse. Stamens to c. 100; filaments membranous, to 18 mm long; anthers to 8.5 mm long, sometimes slightly apiculate. Ovary lobed; carpels 11–22; fruit globose, c. 2.5 cm diam., with numerous seeds; seeds elliptical, c. 1.75–2.5 mm long, c. 1–1.5 mm diam., glabrous; cells of the testa having a small lumen, occasionally raised relative to the arms, with arms of unequal length, ends neither expanded nor raised.

On Cape York in and north of the Jardine River, Queensland; also in New Guinea. Growing in more or less permanent water to 5 m deep, flowering ?April toDecember. Flowers open all day, closing at night.

This species is very similar to *N. hastifolia* Domin but, unlike that species, *N. elleniae* grows in more permanent water and usually does not start flowering until after *N. hastifolia* has finished. There is also a difference in the seeds: the cells of the testa appear to have a 'double wall' in *N. hastifolia* with the appearance of an extra line in scanning electron micrographs of the seed.

N. elleniae differs from *N. violacea* in always being white-flowered, having shorter filaments, and the flowers and leaves being generally smaller; *N. elleniae* also often retains its juvenile leaves for much longer.

Named after my daughter, Ellen A. Jacobs.

QUEENSLAND: Burster Ck, 10° 55' S 142° 22' E, *Clarkson 6185*, Aug 1985 (BRI, NSW); c. 20 km W of Karwah Lagoon, 13° 44' S 141° 54' E, *Clarkson 4568*, Oct 1982 (BRI); Skull Ck, 10° 55' S 142° 22' E, *Jacobs 5458 & Clarkson*, Aug 1987 (NSW). PAPUA NEW GUINEA: Western Province: Pongarihi, c. 30 km E of Morehead, road to Arufi, 8° 40' S, 141° 50' E, *Jacobs 5959 & Conn*, Sept 1990 (NSW, LAE, UPNG); Seki village, N of Morehead 8° 21' S 141° 54' E, *Jacobs 5978 & Conn*, Sept 1990 (NSW, LAE, UPNG).

Nymphaea atrans *S.W.L. Jacobs*, **sp. nov.**

N. giganteae affinis sed floribus fructibusque ad maturitatem vinosis, basi vaginanti petioli latiora, differt.

TYPE: QUEENSLAND: c. 10 km N of Wakooka, Bathurst Bay road, c. 14° 28' S 144° 33' E, *S. Jacobs 5398 & J. Clarkson*, 31 July 1987 (holo NSW; iso BRI).

Perennial with a short vertical swollen rhizome. Petiole base winged; mature leaf blade to c. 40 cm diam.; margins toothed with few regularly-spaced teeth to 2 mm long. Flowers to 40 cm above the water surface. Sepals 4, to 8 cm long, green outside with purple streaks, darkening to maroon with age; the margins membranous, light pink when young and progressively darkening to maroon with age; tip obtuse. Petals to 33, with a gap between petals and stamens, oblanceolate, white with pink tinge, becoming darker with age; tip obtuse. Stamens to c. 300, filaments membranous to cylindrical, to 14 mm long; anthers to 10 mm long, usually with a small hooked apical appendage. Ovary lobed; carpels 10 to 15; fruit globose, c. 4 cm diam., with numerous seeds; seeds elliptical, c. 4 mm long, c. 2.5 mm diam. with discontinuous or disorganised rows of very short hairs; cells of the testa having an elongated lumen with arms of equal length, the ends usually expanded but not raised.

Cape York, Queensland, in Lakefield National Park and its vicinity. Billabongs, lakes and old pastoral dams on floodplains. Flowering ?July to November; flowers open during the morning (and at night?).

Similar to other species in the *'gigantea'* group but differing in the apparent night-flowering, the more developed sheathing base of the petiole, and the petals and sepals darkening with age. The sepals, as well as the fruit, become almost deep maroon as the fruit is drawn beneath the surface. The hairs on the seed are shorter than those on other species in this group. *N. atrans* hybridises with *N. immutabilis* and the hybrids are obvious from the pink older flowers, the flowers of the hybrid never becoming as dark as those of *N. atrans*. The hybrids, unlike both parent species, do not have a good seed-set.

Named from the Latin *atrans*, meaning darkening, referring to the flower darkening with maturity.

QUEENSLAND: Romeo Lagoon, Lakefield National Park, 15° 09' S 144° 15' E, *Jacobs 5414 & Clarkson*, Aug 1987 (NSW, BRI); Low Lake, Lakefield National Park, 14° 38' S 144° 55' E, *Jacobs 5442 & Clarkson*, Aug 1987 (NSW, BRI); 'Bizant', Lakefield National Park, 14° 41' S 144° 12' E, *Williams 85259*, Oct 1985 (BRI).

Nymphaea immutabilis *S.W.L. Jacobs*, **sp. nov.**

N. giganteae affinis sed antheris longioribus, petalis ad maturitatem nonpallescentibus, ciliis seminum seriatum dispositis sed minus ordinatis, differt.

TYPE: QUEENSLAND: c. 1 km SW of Emerald Ck, nr Mareeba, 17° 01' S 145° 30' E, *S. Jacobs 5338 & J. Clarkson*, 26 July 1987 (holo NSW; iso BRI).

Annual or perennial with vertical globular rhizome. Mature leaf blade to c. 70 cm diam.; margins toothed with regularly-spaced teeth to 4.5 mm long. Flowers to 50 cm above the water surface. Sepals 4, to 12.5 cm long, green on the outside with purple flecks; margins membranous and coloured as the outer petals; tip obtuse. Petals to 34, with a gap between petals and stamens, oblanceolate to spathulate, white, sometimes with a blue tinge, or blue, usually not fading with age; tip obtuse. Stamens to c. 400; filaments membranous to cylindrical, to 32 mm long; anthers to 15 mm long, often apiculate. Ovary lobed; carpels 9 to 20; fruit globose, c. 5 cm diam., with numerous seeds; seeds elliptical, c. 4 mm long, c. 2.5 mm diam., with discontinuous or disorganised rows of short, sparse to dense, sometimes almost scattered, hairs, rarely glabrous; cells of the testa having an elongated lumen with arms of equal to unequal length, ends sometimes slightly expanded but not raised.

Widespread in the monsoonal parts of the Australian tropics from the Kimberley, Western Australia to about the Tropic of Capricorn in coastal Queensland. In permanent or ephemeral waterholes. Flowering March to November; flowers open during the day and close at night.

At various times this species has been included in *N. gigantea* or incorrectly known as *N. dictyophlebia* (a synonym of *N. macrosperma*, see below). The distributions of *N. gigantea* and *N. immutabilis* overlap around Rockhampton on the Queensland coast and specimens from this area can be difficult to identify unless collected with seeds, information on flower colour, and whether there is any sign of petal colour fading with maturity. There is presumably some intergradation between the two species in this area.

From the Latin *immutabilis*, not changing, referring to the petals, which usually do not change colour with maturity in this species, unlike *N. gigantea* where those flowers that are originally coloured usually fade, or *N. atrans* where they darken.

There are two subspecies.

1 Petals mostly white, outer whorls often tinged blue, or the petals all white or all blue, not fading with age; sepals to 10.5 cm long; stamens to c. 400; anthers without a gland at the base; leaf blade margin with teeth to 4.5 mm long; carpels 9–19; seeds pubescent ..... subsp. **immutabilis**

1* Petals blue with white at base, fading slightly with age; sepals to 12.5 cm long; stamens to c. 200; anthers with purple gland at base; blade margin with teeth to 3 mm long; carpels 15–20; seeds apparently glabrous ..... subsp. **kimberleyensis**

Nymphaea immutabilis *S.W.L. Jacobs* subsp. **immutabilis**

N. lotus var. *australis* Bailey (1899: 38)

LECTOTYPE (here designated): QUEENSLAND: Kamerunga, Barron R., *E. Cowley 7*, Aug 1891 (BRI).

In the work cited above, Bailey refers the publication of his variety to an earlier work (Bailey 1883); however, while the 1883 publication mentions a variety it offers neither name nor specimen. The name first appears in Bailey (1899) with a somewhat vague specimen citation 'Hab.: Still waters off the Barron River.' The specimen at BRI is clearly labelled by Bailey.

Rhizome swollen and vertical, usually less than 8 cm long. Mature leaf blade with teeth to 4.5 mm long on margin. Sepals to 10.5 cm long. Petals white, with outer whorls often tinged blue, less commonly the petals all white or all blue, not fading with age. Stamens to c. 400; filaments to 28 mm long; anthers to 15 mm long, without a gland at the base. Carpels 9 to 19; fruit globose, c. 5 cm diam.; seeds with discontinuous or disorganised rows of short hairs that sometimes almost appear scattered.

Distribution, habitat, flowering months and flowering times as given for the species.

WESTERN AUSTRALIA: 'Mt House', E of Derby, 17° 12' S 126° 15' E, *Jacobs 4334*, May 1982 (NSW). NORTHERN TERRITORY: 'Singleton' Station, 20° 48' S 134° 16' E, *Henshall 1047*, June 1975 (MEL). QUEENSLAND: Normanton to Karumba road between Normanton and Maggieville, 17°03' S 141° 00' E, *Clarkson 2697*, Nov 1979 (BRI); 'Westmoreland' homestead lagoon, 17° 16' S 138° 15' E, *Jacobs 1551*, May 1974 (NSW); Camooweal, 19° 35' S 138° 07' E, *Jacobs 5531 & P. Wilson*, May 1988 (NSW).

Nymphaea immutabilis subsp. **kimberleyensis** *S.W.L. Jacobs*, **subsp. nov.**

Subsp. *immutabili* affinis sed petalis plerumque ad imum candidis apicem versus violaceis, sepalis longioribus, staminibus paucioribus, differt.

TYPE: WESTERN AUSTRALIA: Kimberley region, *S. Jacobs 5706 & P. Wilson* 23 May 1988 (holo NSW; iso PERTH).

Rhizome swollen and vertical, to 12 cm long. Mature leaf blade with teeth to 3 mm long on margin. Sepals to 12.5 cm long. Petals blue with white at base, fading slightly with age. Stamens to c. 200; filaments to 32 mm long; anthers to 13 mm long, with a purple gland at the base of the anther. Carpels 15 to 20; only immature seeds seen, apparently glabrous.

Known from only one population in the Kimberley, from a lagoon that dries out each year. Flowers open during the day and presumably close at night; flowering from ?March to June. Because of the apparent rarity of this subspecies I have not published precise locality information although this information has been passed on to relevant Government conservation authorities.

WESTERN AUSTRALIA: Kimberley region, *Jacobs 5707 & P. Wilson*, 23 May 1988 (NSW).

Nymphaea violacea and synonyms

Nymphaea violacea Lehm. (1853: 218).

N. gigantea var. *violacea* (Lehm.) Conard (1905: 130–131)

LECTOTYPE (here designated): QUEENSLAND: Cape York, *Macgillivray Voyage of Rattlesnake, Bot. 410*, 10 October 1848 (K).

N. violacea var. *caerulea* Lehm. (1853: 218), as 'coerulea'.

LECTOTYPE (here designated): QUEENSLAND: Cape York, *Macgillivray Voyage of the Rattlesnake, Bot. 410 β*, 27 October 1849 (lecto K; isolecto B).

Lehmann (1853) described two varieties of *N. violacea*, the type variety as α and var. *caerulea* as β. He cited only one specimen from Macgillivray as the type for β and two specimens for α, one collected by Macgillivray and one by Anderson. I have been unable to find any specimens collected by Anderson but found both specimens from Macgillivray clearly labelled at K and a duplicate of one of these at B. Lehmann's herbarium was dispersed after his death, the Nymphaeaceae being purchased by Caspary (Nordenstam 1980). Caspary's herbarium was mostly deposited at B where many specimens were destroyed during World War II, but there are some duplicates at K (Stafleu & Cowan 1976). A search at B revealed a Macgillivray specimen of β that had been damaged by insects, and a substantial collection of Caspary's 'hybrids'. The hybrids were derived from artificially pollinated specimens of what, at that time, were regarded as separate species; nearly all of the parents are now treated by Verdcourt (1989) as synonyms of *N. nouchali* Burm. f. The label of the Macgillivray specimen at B has been altered in an attempt to change the collection date from that for β to that of α, presumably in ignorance of there having been two specimens from the same 'locality' at different dates. Royen (1962) cites the Anderson collection as being in HBG. A search there failed to locate any Australian *Nymphaea* specimens, although there are Anderson collections in other families; there seems no evidence of Caspary's herbarium in HBG. The two specimens at K are in good condition, have the advantage of being in the same herbarium, have been seen and annotated by Lehmann, do not seem to have had their labels altered, and match their relevant descriptions. I am therefore choosing these specimens as lectotypes for Lehmann's two varieties of *N. violacea*.

N. holtzei Rehnelt & Henkel ex Henkel, Rehnelt & Dittman (1907: 67).

TYPE CITATION: 'Gesammelt von Direktor M. Holtze auf den Melville-Inselen, 40 engl. Meilen von Port Darwin'.

LECTOTYPE (here designated): Lefthand figure accompanying the description (Henkel et al. 1907: 67).

I have been unable to find a Holtze specimen labelled with these details. If one existed it was possibly destroyed in B. There are two unnumbered figures accompanying the description. The unnumbered figure on the left is clearly *N. violacea*. *N. stellata* F. Muell. (non Willd.) is a *nomen nudum* cited as a synonym of *N. holtzei* in the protologue, and Mueller used his name for what is now recognized as *N. violacea*. The description of *N. holtzei* is a good match for *N. violacea*. I here designate the lefthand

figure accompanying the description on p. 67 as the lectotype. The unnumbered figure on the right is of the tubers and could belong to a young plant of nearly any Australian species.

N. holtzei var. *albiflora* Rehnelt & Henkel ex Henkel, Rehnelt & Dittman (1907: 67).

TYPE CITATION: 'Eleonorae hort.'

The distinguishing feature of this variety, 'Floribus niveis' is added after the diagnostic description of the species. Flower colour alone is an unreliable character for distinguishing species of *Nymphaea;* this variety *albiflora* presumably consists of common white-flowered plants of *N. violacea.* There is no indication of any specimen or drawing that could be used in lectotypification.

N. rehneltiana Henkel (1910: 154–156).

LECTOTYPE (here designated): Fig. 11 on p. 155 of the protologue.

There is no indication in the original description of a specimen existing other than the statement that the species was cultivated at the Botanic Garden in Giessen. The description matches *N. violacea* and there is an awkward but perfectly adequate and diagnostic drawing in the protologue that I now select as the lectotype.

N. casparyi Rehnelt & Henkel ex Henkel, Rehnelt & Dittman (1907: 66) nom. illeg.; non *N. casparyi* Carrière (1879).

TYPE CITATION: 'Im Herbar Kew liegen Blätter von ihr, gesammelt von Ferd. v. Müller, bezeichnet als versicolor, repanda und serrata. Eines derselben ist mit Banksii Cunn. bezeichnet.'

LECTOTYPE (here designated): 'N. repanda', Head of Sturts Creek, *F. Mueller* (K).

Although it is not necessary to lectotypify illegitimate names there is some value in doing so for this case. Rehnelt and Henkel's name has been used in the literature, sometimes cited as a *nom. illeg.,* and the unnumbered drawing with the protologue has also been referred to. The problem springs from their name being based on collections of two different species. There are four specimens listed by Rehnelt and Henkel, all from K; three of the specimens have been labelled by Mueller as either 'versicolor', 'repanda' or 'serrata' and one labelled as 'banksii' by Allan Cunningham. All the names are *nomina nuda;* the specimens labelled *versicolor, repanda,* and *banksii* are all *N. violacea* and the specimen labelled *serrata* belongs to a species near *N. gigantea* Hook., possibly *N. macrosperma.* The figure with the type description is a composite of the two species, as is the description. In order to reduce confusion I have selected as lectotype the specimen designated above.

New synonym

Nymphaea macrosperma Merrill & Perry (1942: 389).

TYPE: PAPUA NEW GUINEA: Lake Daviumbu, Middle Fly River, *L. Brass 7608,* Aug 1936 (holo A; iso BM, BRI).

N. dictyophlebia Merrill & Perry (1942: 390), **syn. nov.**

TYPE: PAPUA NEW GUINEA: Penzara, between Morehead and Wassi Kussa Rivers, *L. Brass 8437*, Dec 1936 (holo A; iso BM, BRI).

The names *Nymphaea macrosperma* and *Nymphaea dictyophlebia* were both published in the same paper but are referable to the same species. Understandably there has been some confusion in the application of these names although *N. macrosperma* has been used correctly more frequently than *N. dictyophlebia*, the latter name sometimes being used for the species described here as *N. immutabilis*. To minimise changes to current usage I have selected *N. macrosperma* as the name for this taxon.

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Many thanks to Geoff Sainty, John Clarkson and Ian Cowie who, among others, were effective crocodile decoys and collectors of valuable specimens. Thanks also to Carolyn Porter and Sue Chambers for invaluable technical assistance, Joy Everett, Roger Carolin and Helen Aston for their comments on the manuscript, Terry Macfarlane and Greg Leach for help while Australian Botanical Liaison Officers, Karen Wilson for the Latin diagnoses and help while Liaison Officer, and to The Royal Geographical Society and The Linnean Society of London for supporting my participation in the Kimberley Research Project, 1988.

References

Bailey, F.M. (1883) *A synopsis of the Queensland flora*. (Government Printer: Brisbane).

Bailey, F.M. (1899) *The Queensland Flora*, part 1. (H.J. Diddams & Co.: Brisbane).

Carrière, E.A. (1879) *Nymphaea caspary*. *Revue Horticole*: 230 (not seen, quoted in Conard 1905).

Conard, H.S. (1905) *The waterlilies*. (Carnegie Institute: Washington).

Henkel, von F., Rehnelt, F. & Dittman, L. (1907) *Das Buch der Nymphaeaceen oder Seerosengewäschse* (Darmstadt).

Henkel, von F. (1910) *Nymphaea Rehneltiana* Henkel, species nova. *Gartenflora, Zeitschrift fur Garten- und Blumenkunde* 59: 154–156.

Lehmann, C. (1853) Ueber die Gattung *Nymphaea*. *Hamburger Garten- und Blumenzeitung* 9: 193–218.

Merrill, E.D. & Perry, L.M. (1942) Plantae Papuanae Archboldianae X. *Journal of the Arnold Arboretum* 23: 383–416.

Nordenstam, B. (1980) The herbaria of Lehmann and Sonder in Stockholm, with special reference to the Ecklon and Zeyher collection. *Taxon* 29: 279–291.

Royen, P. van (1962) Sertulum Papuanum 5, Nymphaeaceae. *Nova Guinea* 8: 103–126.

Stafleu, F.A., & Cowan, R.S. (1976) *Taxonomic Literature*, edn 2, vol. 1: A–G. (Bohn, Scheltema & Holkema: Utrecht).

Verdcourt, B. (1989) Nymphaeaceae. Pp. 1–12 in R.M. Polhill, (ed.), *Flora of Tropical East Africa* (A.A. Balkema: Rotterdam).

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New species of *Plectranthus* and *Westringia* (Labiatae) from New South Wales

Barry J. Conn

Abstract

Conn, Barry J. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000). New species of Plectranthus *and* Westringia *(Labiatae) from New South Wales.* Telopea *4(4): 643–648 . Plectranthus cremnus* and *Westringia kydrensis* from eastern New South Wales are described.

Introduction

During the preparation of an account of the labiates (Lamiaceae) for the 'Flora of New South Wales' project, two undescribed species were discovered. Although the conservation status is unknown, both appear to be rare and possibly vulnerable. The publication of these two names will enable the species to be formally recognized by the appropriate management authorities.

Terminology and presentation follows that used in Conn (1984 & 1987).

Taxonomy

Plectranthus cremnus *Conn*, **sp. nov.**

TYPE: NEW SOUTH WALES: Sawtell area, *Conn 3478*, 20 February 1990 (holo NSW 224791; iso MEL).

Herba prostrata usque decumbens. *Rami et ramuli* basi subteretes, apicem versus quadrangulatum, moderate usque dense tomentosi, pilis albis brevibus etiam pilis longissimis multicellularibus patentibus eglanduligeris. *Folia* decussata, moderate usque dense tomentosa; *petiolus* 15–20 mm longus; *lamina* depresse ovata usque latissime ovata, 35–40 mm longa, 45–50 mm lata, basi subtruncata, margine bicrenata, apice obtuso usque rotundato. *Verticillastri* quinqueflori. *Bracteae* late ovatae, 1.5–1.6 mm longae, 1.5–1.6 mm latae, deciduae. *Pedicellus floris* 3.5–5 mm longus. *Calyx* marroninus vel in partibus viridis, extra sparsim usque moderate tomentosus, intra glaber; *tubus* circa 0.4 mm longus; *lobus abaxiali–medianus* circa 1 mm longis, apice profunde diviso; *lobi laterales* late deltoidei, 0.6–0.8 mm longi; *par loborum adaxiali–medianorum* latissime obovatum usque transverse late ellipticum, circa 0.6 mm longum. *Corolla* 6 mm longa, lobis indicis, extra in partibus sparsim tomentosa,intra glaber; *tubus* 4.4 mm longus, leviter curvus; *lobus abaxiali-medianus* transverse late ellipticus usque circularis, circa 4.5 mm longus; *lobi laterales* oblique deltoidei, 1–1.3mm longi; *par loborum adaxiali-medianum* transverse truncato-ellipticum, circa 2 mm longum, apice profunde diviso. *Filamenta staminum* 3.5–4.5 mm longa; antherae circa 0.4 mm longae. *Ovarium* 0.2–0.3 mm longum; *stylus* 7.5–8.2 mm longus; *stigma* 0.6–0.8 mm longa. *Mericarpia* compresso–globularia, 0.8–1 mm diametro, latitudine non nisi 0.5–0.6 mm lata; calyx fructifer accrescens.

Prostrate to decumbent herb, pleasantly aromatic with a *Geranium*-like odour. *Branches* basally subterete, distally ridged and appearing quadrangular, moderately to densely hairy [65–80 hairs/mm^2]; indumentum consisting of short (to c. 0.6 mm long) and long (to 6 mm long) hairs; hairs multicellular, patent, white, with shorter hairs slightly curved with apex directed antrorsely; glandular hairs absent. *Leaves* green, decussate, in pairs, moderately to densely hairy [as for branches]; hairs [as for branches]; *petiole* 15–25 mm long; *lamina* depressed to very broadly ovate, 35–40 mm long, 45–50 mm wide [lamina length to width ratio 0.7–0.8, length of maximum width from base to total lamina length ratio 0.3–0.4], base subtruncate, margin bicrenate with 7–10 rounded teeth (each with 1 or 2 secondary teeth), apex obtuse to rounded; venation strongly raised abaxially, sunken adaxially. *Inflorescence* an open spike-like conflorescence, moderately to densely hairy [as for branches]; uniflorescences appearing verticillate, with each uniflorescence a reduced 5-flowered dichasium. *Bracts* broadly ovate, 1.5–1.6 mm long, 1.5–1.6 mm wide [length to width ratio 1], soon deciduous. *Pedicel* (anthopodium+ a_2 axis [ultimate internode basal to anthopodium]) 3.5–5 mm long. *Calyx* with outer surface maroon throughout, or lateral and abaxial lobes green (at least in part), inner surface ± green; outer surface sparsely to moderately hairy [c. 30 hairs/mm^2]; inner surface glabrous; *tube* c. 0.4 mm long; *abaxial median lobes* c. 1 mm long, c. 1.1 mm wide [length to width ratio 0.9], deeply divided (sinus 0.8 mm long, 0.9 mm wide distally) with each lobe narrowly triangular and apex acute; *lateral lobes* broadly triangular, 0.6–0.8 mm long, 0.6–0.8 mm wide [length to width ratio 1], apex acute; *adaxial median lobe–pair* very broadly obovate to transversely broad–elliptic, 0.6 mm long, 0.8 mm wide [length to width ratio 0.7–0.8], apex rounded. *Corolla* 6 mm long, with tube white and lobes bright blue with purple tinge; outer surface glabrous basally, sparsely hairy on lobes; inner surface glabrous; *tube* 4.4 mm long, tubular, slightly inflated adaxially, slightly curved at c. 2 mm from base at an angle of c. 30°; *abaxial median lobe* transversely broad-elliptic to circular, c. 4.5 mm long, 4.5–5 mm wide, with apex rounded; *lateral lobes* obliquely triangular, 1–1.3 mm long, 1–1.5 mm wide [length to width ratio 1–1.5], with apex obtuse; *adaxial median lobe–pair* transversely truncate-elliptic, c. 2 mm long, 3.7 mm wide distally [length to width ratio 0.4–0.5], deeply bilobed (sinus 1 mm long, 0.3 mm wide distally, each lobe transversely broad-elliptic, c. 1.5 mm long, c. 2 mm wide). *Staminal filaments* with purple tinge, inserted c. 2 mm above base of corolla, 3.5–4.5 mm long, glabrous; *anthers* c. 0.4 mm long, c. 0.3 mm wide. *Disk* 0.5 mm long. *Gynoecium* glabrous; ovary 0.2–0.3 mm long; style 7.5–8.2 mm long; stigma lobes 0.6–0.8 mm long. *Mericarps* compressed-spherical, 0.8–1 x 0.8–1 x 0.5–0.6 mm, smooth, glossy dark brown; calyx enlarging in fruit and lobes ± enclosing developing seed, with abaxial lobes incurved, c. 2.2 mm long, 1.5 mm wide, lateral lobes incurved, c. 1.7 mm long, c. 1 mm wide, adaxial lobe-pairs c. 2.1 mm long, c. 2.6 mm wide. Fig. 1 (a–c).

Distribution: Only known from Evans Head, Lennox Head and Sawtell, North Coast, New South Wales.

Habitat: A rare herb growing in shallow sandy soil that has been deposited by wind into the crevices of the bare basaltic outcrops of coastal headlands.

Affinities: The affinities of this species are not known and must await the conclusions of a detailed phylogenetic evaluation of the genus. Unfortunately, the most recent account of the Australian species (Blake 1971) does not comment on infrageneric relationships. It is superficially similar to *P. graveolens*, however it can be distinguished from this latter species by having 3–5 pairs of teeth (total of 7–10 teeth) on the margin of the leaf (cf. 10–23 pairs of teeth in *P. graveolens*), being pleasantly aromatic (cf. *P. graveolens*, which is strongly and unpleasantly aromatic) and this species is prostrate (cf. the latter, which is suberect to erect). It can be distinguished from the

Figure 1. *Plectranthus cremnus*. **a**, branch and inflorescence; **b**, leaf; **c**, flower (all from *Conn 3478*). *Westringia kydrensis*. **d** flowering branchlet; **e** calyx and prophyll in leaf axil; **f** whorl of three leaves (all from *Rodd 2652*). Scale bar: a = 5 mm; b, c = 2 mm; d, e = 1 cm; f = 1 mm.

P. parviflorus/P. suaveolens group by the absence of glands and by the presence of ± patent hairs (cf. the latter group, which has ± appressed, retrorse hairs).

ETYMOLOGY: The specific epithet refers to the occurrence of this species on coastal rocky cliffs.

CONSERVATION STATUS: Although the conservation status of this species is uncertain, it is very rare at Evans Head and Sawtell (*Conn 3478*). At Lennox Head it is relatively common locally (R. Miller, pers. comm.). However, this species is vulnerable at all known localities. Risk Code = 3V (*sensu* Briggs & Leigh 1988).

NOTES: In horticulture, this species is a vigorously growing ground cover, which flowers throughout the year. It has been successfully cultivated at the Royal Botanic Gardens, Sydney and is commonly referred to as *Plectranthus graveolens* 'Headland Form'.

OTHER SPECIMENS EXAMINED: NEW SOUTH WALES:(NORTH COAST): Kendall, *F.M. Bailey s.n.*, Sep 1929 (NSW 31978); Lennox Head, *R. Miller s.n.*, 11 June 1991 (MEL, NSW 240476); Sawtell Headland, *P. Wilson s.n.*, – (NSW 241355); (cultivated at Frenchs Forest) ex Sawtell, *D. Blaxell s.n.*, 15 Jan 1969 (NSW).

Westringia kydrensis Conn, **sp. nov**.

TYPE: NEW SOUTH WALES: Kydra Reefs, *Rodd 2652*, 22 Mar 1974 (holo NSW 216148; iso CANB, MEL).

Frutices usque ad circa 0.4 m. alti. *Rami et ramuli* subteretes, dense tomentosi usque glabrescenti. *Folia* verticillata terna, moderate usque sparsim tomentosa; *petiolus* 1–1.5 mm longus; *lamina* obovata usque elliptica, 5.5–7 mm longa, 2.2–3 mm lata, basi cuneata, margine integro et plano,apice obtuso. *Pedicellus floris* circa 0.5 mm longus, dense tomentosus; *prophyllis* anguste ellipticis usque anguste oblongis, 3–4 mm longis, 0.5–0.7 mm latis, dense tomentosis. *Calyx* probabiliter viridis, extra moderate usque dense tomentosus; *tubus* 2.5–3.2 mm longus, intra glaber; *lobi* deltoidei, 2.5–4.8 mm longi, 1.2–1.7 mm lati, intra moderate tomentosi, apice acuto. *Corolla* 8–10 mm longa, alba, extra in partibus distalibus moderate tomentosa, intra sparsim usque moderate tomentosa; *tubus* 3.5–4.5 mm longus; *lobus abaxiali-medianus* late usque latissime spathulatus, 3.5–4 mm longus, 3–5 mm latus; *lobi laterales* oblongi, 3 mm longi, 1.5 mm lati; *par loborum adaxiali–medianorum* late oblongum usque latissime obovatum, 4.5–6 mm longum, 4–8.5 mm latum. *Androecium* in ore corollae insertum; filamenta staminum 0.8–1 mm longa; antherae circa 1 mm longae; filamenta staminodiorum 0.8–1 mm longa; lobi staminodiorum 0.2–0.3 mm longi. *Pistillum* 8.4–9.5 mm longum; ovarium circa 1 mm longum; stylus 7–8 mm longus; stigma 0.4–0.6 mm longa. *Mericarpia* incognita.

Erect shrub to c. 0.4 m high. *Branches* subterete (internodes with slightly raised undulate ridge-pairs from axil of leaf to next more distal node), moderately to densely hairy distally and between ridge–pairs [to c. 70 hairs/mm^2], otherwise sparsely hairy to glabrescent; hairs simple, ± straight, subappressed, antrorse, 0.1–0.2 mm long, white. *Leaves* in 3-leafed whorls, spreading to ascending, sparsely to moderately hairy [to 25 hairs/mm^2], soon glabrescent with the hair bases persistent; hairs simple, ± straight, appressed, antrorse; *petiole* 1–1.5 mm long; *lamina* obovate to elliptic, 5–8 mm long, 2.2–3 mm wide [lamina length to width ratio 2–2.5, length of maximum width from base to total lamina length ratio 0.5–0.7], base cuneate, margin entire and flat, apex obtuse; venation not visible, midrib with only basal part slightly raised on abaxial surface. *Inflorescence* a frondose racemiform conflorescence, uniflorescence monadic, up to c. 6 flowers per conflorescence. *Pedicel* c. 0.5 mm long,

densely hairy [as for distal parts of branches]; *prophylls* inserted at base of calyx, narrowly elliptic to narrowly oblong, 3–4 mm long, 0.5–0.7 mm wide [length to width ratio 4.3–6.7, length of maximum width from base to total lamina length ratio 0.5–0.6], densely hairy [90–96 hairs/mm^2], base cuneate, margin incurved, apex tapering. *Calyx* ? green; outer surface moderately to densely hairy [70–80 hairs/mm^2], often glabrescent basally; *tube* 2.5–3.2 mm long, inner surface glabrous; *lobes* triangular, 1.6–2 mm long, 1.2–1.7 mm wide [length to width ratio 1.2–1.3], inner surface moderately hairy, apex acute; [calyx lobes to tube ratio 0.6–0.7]. *Corolla* 8–10 mm long, white, with a few small reddish dots at base of abaxial lobes; outer surface glabrous basally, moderately hairy on distal part of tube and on lobes [45–55 hairs/mm^2], with hairs 0.2–0.4 mm long, ± appressed; inner surface sparsely to moderately hairy [20–40 hairs/mm^2], 0.2–0.4 mm long, appressed to subpatent, straight to variously bent; *tube* 3.5–4.5 mm long, tubular, diameter at mouth 2–3 mm; *abaxial median lobe* broadly to very broadly spathulate, 3.5–4 mm long, 3–5 mm wide distally, deeply bilobed (sinus to 3 mm long), with apex irregularly truncate and/or lobed; *lateral lobes* oblong, sometimes narrowly so, 3–3.5 mm long, 0.7–2 mm wide [length to width ratio 1.7–4], with apex rounded and slightly irregular, often shortly bilobed; *adaxial median lobe–pair* broadly oblong to very broadly obovate, 4.5–6 mm long, 4–8.5 mm wide distally (length to width ratio 0.7–1.1), with apex ± irregularly subtruncate, deeply bilobed (sinus 2–3.5 mm long). *Androecium* inserted in mouth of corolla. *Staminal filaments* 1.8–2 mm long, glabrous or hairy at base; anthers c. 1 mm long. *Staminodal filaments* 0.8–1 mm long, glabrous; staminodal lobes white, 0.2–0.3 mm long. *Disc* 0.4–0.5 mm high. *Pistil* 8.4–9.5 mm long; ovary c. 1 mm long; style 7–8 mm long, glabrous; stigma lobes 0.4–0.6 mm long. *Mericarps* immature. Fig. 1 (d–f).

Distribution: Kydra Reefs, c. 23 km SE of Cooma, Southern Tablelands, New South Wales.

Habitat: Frequent in heath, amongst larger shrubs of *Allocasuarina nana* and *Banksia canei*. Occurring on rocky granite or quartzite hillside (*Rodd 2652*).

Affinities: The affinities of this species are not fully understood; however, it appears to belong to the group that has relatively large prophylls. Of this group, it is most similar to *W. davidii* from which it can be distinguished by its appressed antrorse indumentum (cf. *W. davidii*, which has subpatent and more or less tangled hairs).

Etymology: The specific epithet refers to the occurrence of this species in the Kydra Reefs area of New South Wales.

Conservation status: This new species of *Westringia* is only known from the type collection, from the Kydra Reefs area of New South Wales. Since the distribution of this species is not known, it is difficult to comment on its conservation status. However, the only known population does not occur in a conservation reserve. Risk Code = 2K (Briggs & Leigh 1988).

Acknowledgments

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References

Blake, S.T. (1971) A revision of *Plectranthus* (Labiatae) in Australasia. *Contrib. Queensland Herb.* 9: 1–120.

Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants – 1988 revised edn.* Austral. Natl. Parks & Wildlife Service Special Publication No. 14: 1–278.

Conn, B.J. (1984) A taxonomic revision of *Prostanthera* Labill. section *Klanderia* (F.v. Muell.) Benth. (Labiatae). *J. Adelaide Bot. Gard.* 6: 207–348.

Conn, B.J. (1987) Two new species of *Westringia* (Labiatae) from New South Wales. *Muelleria* 6: 321–328.

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Status of the genus *Eichlerago* (Labiatae)

Barry J. Conn

Abstract

Conn, Barry J. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, NSW, Australia 2000). Status of the genus Eichlerago *(Labiatae).* Telopea *4(4): 649–651. Eichlerago* is reduced to a synonym of *Prostanthera* and the new combination *Prostanthera tysoniana* (Carrick) Conn is made. This species is regarded as belonging to *Prostanthera* section *Prostanthera*. Notes on the habitat, distribution and conservation status are included.

Introduction

Eichlerago was described by Carrick (1977) as a new genus of the Lamiaceae, with close affinities to *Prostanthera*. He concluded that the genus was sufficiently distinct from other labiate genera to be placed in his new monotypic tribe Eichleragineae (within the subfamily Prostantheroideae *sensu* Briquet 1895). However, the features that Carrick used to distinguish this genus from *Prostanthera* are either plesiomorphic or (it is believed) incorrectly interpreted.

The infrafamilial classification used in this paper is based on that of Bentham in Bentham & Hooker (1876), as modified by Erdtman (1945). Hence, the Prostantheroideae *sensu* Briquet (1895) is referred to as the tribe Prostantheреae *sensu* Bentham in Bentham & Hooker (1876), of the subfamily Lamioideae *sensu* Erdtman (1945).

Discussion of Characters

Carrick concluded that the shape of the corolla in *Eichlerago* could be used to distinguish this genus from *Prostanthera*. However, contrary to his interpretation, the 3-lobed abaxial (lower) corolla lip in *Eichlerago* is typical of most species of *Prostanthera* (particularly in *Prostanthera* section *Prostanthera*. Of the fruiting characters that Carrick regarded as diagnostic, only the reduced distal lobing is apomorphic. However, this condition is a convergence that is also found in *Prostanthera queenslandica*. The other fruiting characters that he used include 'fruits dry' and 'fruits indehiscent'. The 'dry' rather than fleshy, fruit condition is a plesiomorphy, characteristic of all Labiatae. It is not known whether the fruits of *Eichlerago* are indehiscent or dehiscent. It is possible that they are a foraminose schizocarp, not dissimilar to those of the Prostantheреae (Conn 1984). Finally, Carrick regarded the position of the style as a diagnostic character. However, the terminal style is also a plesiomorphy. This character distinguishes the Prostantheреae and Ajugeae from the other Labiatae which have a gynobasic style (Conn 1984, Sharma & Singh 1982).

In an evaluation of relationships within the tribe Prostantheреae (Labiatae), *Eichlerago* and *Prostanthera* formed a clade characterised by four synapomorphies (Conn, in press). These characters were: the anther connective extended into a basal appendage, or if appendage absent (in some species of *Prostanthera*) then regarded as a secondary loss; the anther connective cristate with triangular trichomes; the leaves aromatic, or if non-aromatic (in a few species of *Prostanthera*) then regarded as a

secondary loss; and the anther lobe terminating in a basal acumen. *Eichlerago* and *Prostanthera* section *Prostanthera* form the sister group to *Prostanthera* section *Klanderia*. The former clade is characterised by the adaxial lip of the calyx enlarging (often significantly) as the fruit matures. Some enlargement of the calyx has been noted in fruiting material of *E. tysoniana* (*Payne 107 & 126*).

Discussion of Infratribal Classification

Although it is premature to formally recognize infratribal groupings within the Prostantheae, the current evaluation of the phylogeny of this tribe (Conn, in press) does not support Carrick's interpretation that all genera (apart from *Eichlerago*, which he placed in Eichleragineae) belong in one group (Prostantheae *sensu* Carrick 1977). Within the Prostantheae, Conn (in press) recognizes two main groups. One group (the *Prostanthera* clade) consists of *Prostanthera* (including *Eichlerago* and both sections of *Prostanthera*) and *Wrixonia*, with the other group (the *Microcorys* clade) consisting of *Hemiandra*, *Hemigenia*, *Microcorys* and *Westringia*. Therefore, there is even less support for the 'Eichleragineae' than there is for *Eichlerago*.

Conclusion

It is concluded that *Eichlerago* cannot be maintained as a distinct monotypic genus and it is here proposed that it become part of *Prostanthera* section *Prostanthera*.

Taxonomy

Prostanthera *Labill.*, Nov. Holl. Pl. Spec. 2: 18, t. 157 (1806).

Type species: *Prostanthera lasianthos* Labill.

Type: 'Van-Diemen', *Labillardière s.n.*, – (n.v.).

Eichlerago Carrick, J. Adelaide Bot. Gard. 1: 115 (1977).

Type species: *Eichlerago tysoniana* Carrick

Type: *Tyson 25* (for details refer below).

Prostanthera tysoniana *(Carrick) Conn*, **comb. nov.**

Basionym: *Eichlerago tysoniana* Carrick, J. Adelaide Bot. Gard. 1: 115, fig. 1 (1977). Holotype: Western Australia: 'Mt Narryer, Murchison River', *I. Tyson 25*, 1898 (PERTH); iso K.

Description: Refer Carrick (1977).

Habitat: Open *Acacia brachystachya*-dominated shrubland on shallow (0.5–0.7 m deep) red sandy soils of the sandplain, overlying Permian lateritic-rich plains.

Distribution: This rare species is endemic to the Byro–Mt Narryer area of Western Australia.

Conservation status: The Rangeland Survey Team of the Department of Agriculture, Western Australia, have located this species on the Byro, Curbur, Mt Narryer and Muggon pastoral properties (Ray Cranfield pers. comm., 10 June 1991). Its distribution reflects the very geographically restricted interzone of Permian and wash plains, which only occurs on three or four properties in this area (P. Curry in Cranfield pers. comm., 6 September 1991). Therefore the species is confined to an area of about 300 km^2. Although the distribution of this species is restricted, the known populations contain several hundred plants, with seedlings reported as either very common (*Conn 2083*, *Conn 2091–2096* and Cranfield pers. comm., 10 June 1991) or none seen (P. Curry in Cranfield pers. comm., 6 September 1991). Irrespective of the number of seedlings, the percentage that mature in this harsh environment may be very low, particularly because it is heavily grazed by stock and kangaroos.

Although more information about the distribution of this species is now available, the Western Australian Department of Conservation and Land Management consider it to be a 'Priority 1' species. That is, a species under immediate threat and under consideration for declaration as rare flora, but in need of urgent high priority further survey. Therefore, the risk code of 2K (applied by Briggs & Leigh 1988) should be changed to 2V.

Other specimens examined: Western Australia: Austin: 'Upper Murchison R. [River]', *I. Tyson 4*, 1892 (MEL 41916); Byro Station, c. 28 km NW of Mullewa–Gascoyne Junction Road, on road to Woodleigh Station, *Conn 2083*, 11 Sep 1985 (MEL, PERTH), *Conn 2091*, 12 Sep 1985, (AD, CANB, MEL, PERTH), *Conn 2092* [this and all following specimens collected on same day as *Conn 2091*](BRI, MEL, PERTH), *Conn 2093* (MEL, PERTH), *Conn 2094* (MEL, NSW, PERTH, RSA), *Conn 2095* (CANB, MEL, PERTH), *Conn 2096* (AD, CHR, MEL, MO, PERTH), *Conn 2098* (CANB, MEL, NSW, PERTH), *Cranfield 5162*, 21 June 1985 (PERTH); Curbur Station, *Payne 107*, 31 Oct 1985 (PERTH), *Payne 126*, Oct 1985 (PERTH).

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Mr Ray Cranfield (PERTH) provided additional distribution information, incorporating data obtained by the Rangeland Survey Team (Department of Agriculture, Western Australia) and information from the Western Australian Department of Conservation and Land Management. This study was supported by an Australian Biological Resources Study Grant.

References

Bentham, G. & Hooker, J.D. (1876) *Genera plantarum*, vol. 2 (Reeve: London).

Briggs, J.D. & Leigh, J.H. (1988) *Rare or threatened Australian plants – 1988 revised edn.* Austral. Natl. Parks & Wildlife Service Special Publication no. 14.

Briquet, J. (1895) Labiatae p.p. Pp. 183-221 in Engler, A. & K. Prantl (eds), *Die Natürlichen Pflanzenfamilien*, Teil IV, Abteilung 3a (Engelmann: Leipzig).

Carrick, J. (1977) Studies in Australian Lamiaceae 2. *Eichlerago*, a new genus allied to *Prostanthera*. *J. Adelaide Bot. Gard.* 1: 115-122.

Conn, B.J. (1984) A taxonomic revision of *Prostanthera* section *Klanderia* (F.v. Muell.) Benth. (Labiatae). *J. Adelaide Bot. Gard.* 6: 207–348.

Conn, B.J. (in press) Relationships within the tribe Prostanthereae (Labiatae). In Harley, R.M. & Reynolds, T. (eds). *Advances in Labiate Science* (Royal Bot. Gard., Kew: London).

Sharma, M. & Singh, V. (1982) Morphology of the gynoecium in Labiatae. *Blumea* 28: 61–75.

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New taxa and a new combination in *Triodia* (Poaceae)

S.W.L. Jacobs

Abstract

Jacobs, S.W.L. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, N.S.W., Australia, 2000) 1992. New taxa and a new combination in Triodia *(Poaceae).* Telopea *4(4): 653–659.* The *Triodia irritans* complex is reassessed. *T. irritans* var. *laxispicata* is treated as a synonym of *T. scariosa*; a new combination is made for *T. compacta*; and *T. scariosa* subsp. *bunicola*, *T. scariosa* subsp. *yelarbonensis*, *T. truncata*, *T. tomentosa* and *T. radonensis* are described as new. All but the last species belong to the *T. irritans* group.

Introduction

Burbidge (1953) treated the *Triodia irritans* complex by recognising *T. irritans*, *T. scariosa*, *T. lanata* and three varieties within *T. irritans*: var. *irritans*, var. *compacta* and var. *laxispicata*. Three informal forms (designated A, B and C) were described in *T. irritans* var. *laxispicata*. Unfortunately, the type of *T. irritans* var. *laxispicata* is conspecific with *T. scariosa*. Rectifying this problem for the 'Flora of New South Wales' presents an opportunity for a reassessment of the *T. irritans* complex and the description of some new taxa.

The *T. irritans* complex

Two of the forms of *T. irritans* var. *laxispicata* ('B' and 'C') are geographically isolated and show little character overlap, can be recognised in the field, and are as distinct as varieties recognised in *T. mitchellii* and *T. pungens* (Burbidge 1953, 1960). *T. irritans* var. *compacta* is distinct from both *T. scariosa* and *T. irritans* and, if anything, is more closely related to the former than to the latter. *T. irritans* var. *compacta* is here recognised at the species level as *T. compacta*. *T. compacta* differs from both in the shorter rhachilla segments and denser-flowered spikelets with almost twice the number of florets per spikelet. Similar relative glume lengths and emarginate lemmas are shared by *T. compacta* and *T. scariosa*. To reflect the taxonomic situation and to simplify communication by changing the present subspecific classification from two formal levels and one informal level to a system of two formal levels, I propose to recognise *T. irritans* var. *compacta* at the species level, treat *T. irritans* var. *laxispicata* form 'A' as a synonym of *T. scariosa* and to recognise forms 'B' and 'C' of *T. irritans* var. *laxispicata* as subspecies of *T. scariosa*.

Triodia compacta *(N.T. Burbidge) S.W.L. Jacobs*, **comb. et stat. nov.**

Basionym: *Triodia irritans* var. *compacta* N.T. Burbidge (1953: 169).

Lectotype (here designated): South Australia: Elliston Beach, Eyre Peninsula, *J.H. Willis*, 26 Aug 1947 (CANB); isolecto MEL.

Burbidge designated both specimens as the 'holotype'; I have selected the specimen at CANB where she worked as lectotype.

Triodia scariosa *N.T. Burbidge* (1953: 173).

HOLOTYPE: WESTERN AUSTRALIA: Pioneer Rock, N of Lake Cowan, *N.T. Burbidge 2675* (CANB).

Triodia scariosa subsp. **scariosa**

Triodia irritans var. *laxispicata* N.T. Burbidge (1953: 171), **syn. nov.**

LECTOTYPE (here designated): NEW SOUTH WALES: South Far Western Plains: Tooleybuc, *J. Vickery*, 14 Oct 1949 (CANB); isolecto NSW.

Burbidge designated both specimens as the 'holotype'; I have selected the specimen at CANB, where she worked, as lectotype.

T. irritans var. *laxispicata* N.T. Burbidge 'forma A' belongs here.

Triodia scariosa subsp. **bunicola** *S.W.L. Jacobs*, **subsp. nov.**

Subsp. *scariosae* affinis, sed lemmatibus glumisque longioribus, spiculis longioribus latioribusque, differt.

HOLOTYPE: SOUTH AUSTRALIA: Flinders Ranges N of Hawker, *S. Jacobs*, 19 Aug 1966 (SYD).

Hummock-forming perennial. Leaf sheath, orifice and blade glabrous, blade pungent-pointed. Inflorescence paniculate, contracted, 15–30 cm long. Spikelets 12–20 mm long, 7–10 mm wide when lemmas divergent. Glumes 8–12 mm long. Lowest lemma 8–10 mm long; lemma apex emarginate, mucro usually absent. Palea shorter than to subequal to its subtending lemma.

Based more or less on *T. irritans* var. *laxispicata* N.T. Burbidge 'forma B' but with a 'type' different to that indicated in the informal publication of that form and excluding those of the originally cited specimens not from the southern Flinders Range.

From the Greek *bounos* (Latinised to *bunus*), hill or mound, and the Latin *-cola*, dweller, i.e. hill-dweller.

HABITAT: On hill slopes and once-wooded areas now often cleared for grazing.

DISTRIBUTION: On slopes of the Flinders Ranges and adjacent areas, South Australia.

SELECTED SPECIMENS: SOUTH AUSTRALIA: Port Germein Pass, *Blake 16856*, 29 Aug 1946 (NSW, BRI); between 'Yednalue' and Flinders Ranges, *Jacobs*, 22 Aug 1966 (SYD); N of Hawker on main road, *Jacobs*, 20 May 1966 (SYD); Flinders Range, *Koch*, Oct 1901 (NSW).

Triodia scariosa subsp. **yelarbonensis** *S.W.L. Jacobs*, **subsp. nov.**

Subsp. *scariosae* affinis, sed spiculis angustioribus, lemmatibus villosioribus brevioribus latioribusque, differt.

HOLOTYPE: NEW SOUTH WALES: North Western Slopes: on New South Wales–Queensland border, *P. Vickery*, c. 1933 (NSW).

Hummock-forming perennial. Leaf sheath, orifice and blade glabrous, blade pungent-pointed. Inflorescence paniculate, contracted, 10–25 cm long. Spikelets 7–18 mm long, 3–5 mm wide when lemmas divergent. Glumes 5.5–7 mm long, often lightly scabrous. Lowest lemma 4.5–6 mm long, comparatively shorter and with longer hairs (to 1.5 mm long) than in the other subspecies; apex emarginate, usually with a short mucro.

Based on *T. irritans* var. *laxispicata* N.T. Burbidge 'forma C'.

Named after a small town, Yelarbon, near the centre of its distribution.

Habitat: Poor alluvial soils along the Dumaresq River and some of its northern tributaries.

Distribution: Both sides of the Queensland–New South Wales border from about Inglewood to Goondiwindi.

Specimens examined: Queensland: Goondiwindi, *Shirley 4525/19*, Nov 1919 (NSW); Inglewood–Texas road, 4 km from Inglewood, *Simon 2864A, Pedley & McDonald*, 3 Sept 1975 (BRI, NSW); c. 2 km S of Yelarbon, Keetah Bridge-Yetman road, *Wilson 1367*, Oct 1975 (NSW).

Triodia truncata S.W.L. Jacobs, **sp. nov.**

T. scariosae affinis sed apice lemmatis lacerato truncatoque, costa lemmatis excurrente, lemmatibus 3-nervibus brevioribus latioribusque, differt.

Holotype: South Australia: 56 miles [90 km] WNW of Emu, *N. Forde 537*, 14 Sept 1956 (NSW); iso CANB.

Hummock-forming perennial. Leaf sheaths glabrous, smooth, 2–3 mm wide, the margins with a few hairs to 0.5 mm long near the top; orifice with a few hairs to 0.5 mm long that become woolly with age, ligule a ciliate rim; blade to c. 12 cm long, permanently folded, pungent-pointed. Inflorescence paniculate, contracted, 10–15 cm long. Spikelets 4–6-flowered, 10–12 mm long. Glumes equal, c. 7 mm long, broadly lanceolate, acute, scabrid along the midrib. Lowest lemma c. 7 mm long, 3 mm wide, 3-nerved, hairy in the lower half with hairs to 2 mm long; apex raggedly truncate, very shortly ciliate, with the midnerve excurrent as a scabrid mucro 0.25–0.5 mm long. Palea c. 5 mm long, with a few tangled hairs to 1 mm long at the base; apex minutely 2-lobed. Stamens 3, c. 3 mm long. Caryopsis not seen. Fig. 1.

Habitat: Reportedly in interdune areas with *Acacia aneura*.

Distribution: Known only from the type.

Named for the characteristically truncate lemmas.

Triodia tomentosa S.W.L. Jacobs, **sp. nov.**

T. lanatae affinis sed glumis longioribus glabrisque, lemmatibus longioribus acutisque, differt.

Holotype: Western Australia: Great Northern Highway, 6 km SW of Paynes Find, 29°18'S 117°36'E, *M.G. Corrick 9324*, 24 Oct 1984 (NSW); iso MEL.

Hummock-forming perennial to c. 40 cm diam. Sheaths 2–3 mm wide, woolly-hairy with hairs c. 1 mm long; the orifice with similar tangled hairs and these extending

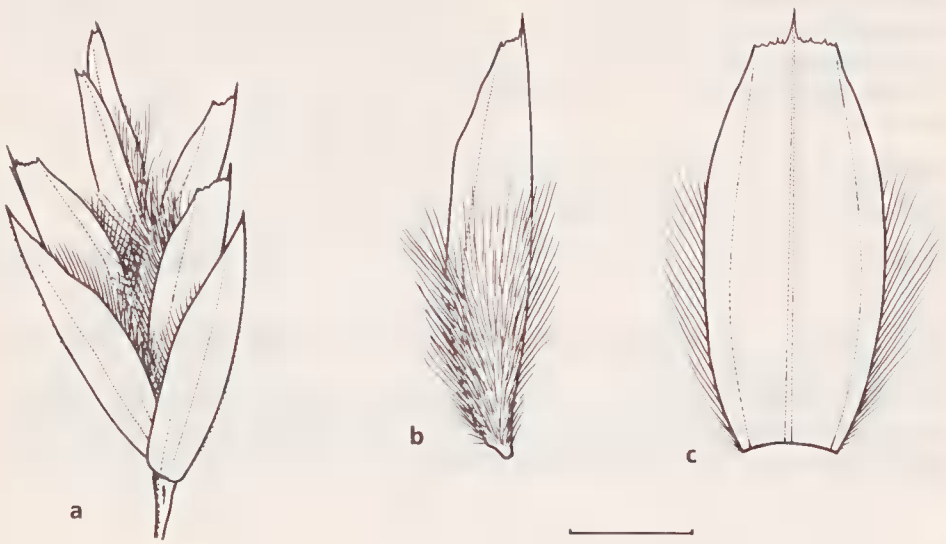

Fig. 1. *Triodia truncata* **a**, whole spikelet; **b**, lateral view of lemma; **c**, adaxial view of lemma. Scale bar = 3 mm for a, = 2 mm for b & c. Drawn from *N. Forde 537* (NSW) by David Mackay.

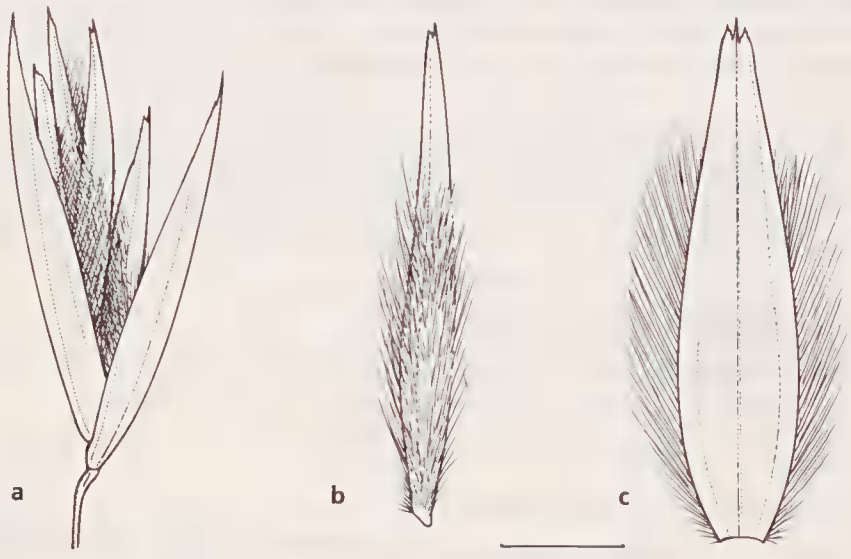

Fig. 2. *Triodia tomentosa* **a**, whole spikelet; **b**, lateral view of lemma; **c**, adaxial view of lemma. Scale bar = 3 mm for a, = 2 mm for b & c. Drawn from *M.G. Corrick 9324* (NSW) by David Mackay.

5–15 mm up the adaxial surface of the blade; blades to c. 10 cm long, permanently folded, pungent-pointed, glabrous except near the orifice. Inflorescence paniculate, contracted, 10–15 cm long. Spikelets 12–14 mm long, 4–5-flowered. Glumes equal, lanceolate, scarious, acute to aristate, 11–12 mm long, glabrous. Lowest lemma 3-nerved, 9–10 mm long, with hairs c. 2 mm long over the lower 60%; the apex acute, emarginate, with the midnerve excurrent as a mucro 0.25–0.5 mm long. Palea acute, entire, c. 90% the length of the lemma, with scattered hairs c. 1 mm long at the base. Stamens 3, c. 4 mm long. Mature caryopsis not seen, immature caryopses typically chloridoid. Fig. 2.

HABITAT: Reportedly from an open woodland of *Melaleuca* and *Acacia*.

DISTRIBUTION: Only known from the type.

Named from the tomentose hairs of the sheath, orifice and lower blade.

Key to the *T. irritans* group

1 Leaf sheath and orifice glabrous or almost so 2

1* Leaf sheath and orifice with woolly hairs 7

2 Lemma apex raggedly truncate, the midnerve excurrent as a mucro ..... **T. truncata**

2* Lemma apex emarginate, obtuse or acute; if the midnerve excurrent then between lobes 3

3 Midnerve excurrent as a short awn between and longer than the stiff lobes; glumes subequal to the spikelet ..... **T. irritans**

3* Lemma apex emarginate, sometimes with a mucro shorter than the lobes; glumes usually shorter than the spikelet 4

4 Spikelets 8–12-flowered; lemmas closely distichous, lower rhachilla segments usually <1 mm long ..... **T. compacta**

4* Spikelets mostly less than 8-flowered; lemmas loosely distichous, lower rhachilla segments usually >1 mm long ..... **T. scariosa** and subspp. 5

5 Mature spikelets with divergent lemmas usually <5 mm wide; lowest lemma 4.5–6 mm long ..... **T. scariosa** subsp. **yelarbonensis**

5* Mature spikelets with divergent lemmas usually >5 mm wide; lowest lemma 6 mm long or more 6

6 Glumes 5.5–9 mm long; lowest lemma 6–7 mm long .... **T. scariosa** subsp. **scariosa**

6* Glumes 8–12 mm long; lowest lemma 8–10 mm long ... **T. scariosa** subsp. **bunicola**

7 Glumes glabrous, 11–12 mm long; lowest lemma 9–10 mm long ..... **T. tomentosa**

7* Glumes hairy, 7–10 mm long; lowest lemma 6–8 mm long ..... **T. lanata**

Triodia pungens group

Triodia radonensis S.W.L. Jacobs, **sp. nov.**

T. microstachyae affinis sed glumis emarginatis vel 2-lobis, paleis alatis, lemmatibus tumidis induratisque, lobis lemmatis minutis membranaceisque, differt.

HOLOTYPE: NORTHERN TERRITORY: Radon Creek, Brockman Range, *P.K. Latz 7676*, 10 June 1978 (NSW); iso BRI, CANB, DNA, PERTH, K.

Viscid perennial forming loose hummocks to c. 5 m diam. Sheaths loose, to 15 mm wide; orifice with a few hairs to 0.5 mm long matted with resin; blades loosely folded, to c. 60 cm long, curved, not pungent-pointed. Inflorescence paniculate, open, 15–25 cm long. Spikelets 4–6-flowered, 6–8 mm long, c. 4 mm wide when the lemmas divergent, appearing open with rhachilla segments c. 1 mm long. Glumes subequal, membranous, c. 2 mm long, emarginate or 2-lobed, the lobes obtuse. Lowest lemma 2–3 mm long, 3-nerved, glabrous or the margins with very few scattered hairs, shiny, swollen and indurated; apex membranous, minutely 3-lobed. Palea subequal to the lemma, winged and the wings visible in the spikelet and ciliolate. Stamens 3, 2 mm long. Mature caryopses not seen. Fig. 3.

HABITAT: Sandy levee banks.

DISTRIBUTION: Known only from the type locality.

Named from the locality, Radon Creek in the Brockman Range, Northern Territory.

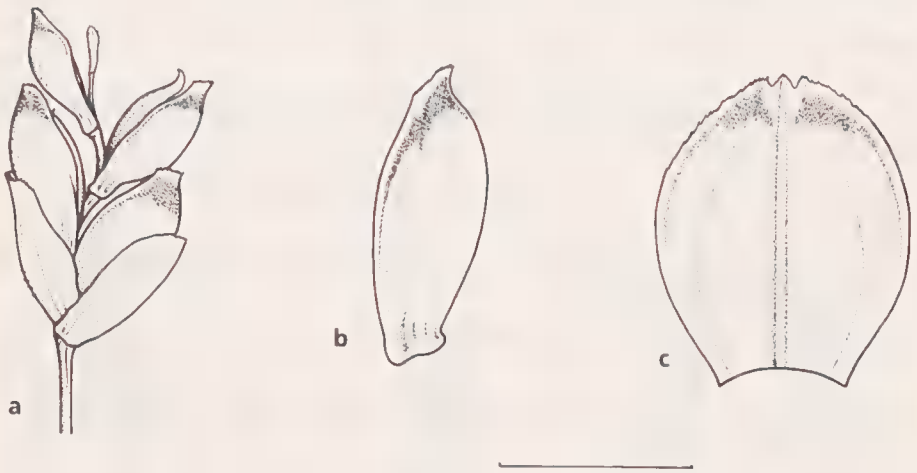

Fig. 3. *Triodia radonensis* **a**, whole spikelet; **b**, lateral view of lemma; **c**, adaxial view of lemma. Scale bar = 3 mm for a, = 2 mm for b & c. Drawn from *P.K. Latz 7676* (NSW) by David Mackay

Acknowledgments

Many thanks to Karen Wilson for the Latin diagnoses, to Ken Hill for his helpful comments on the manuscript, and to David Mackay for his excellent art work.

References

Burbidge, N.T. (1953) The genus *Triodia* R. Br. (Gramineae). *Australian Journal of Botany* 1: 121–184.

Burbidge, N.T. (1960) Further notes on *Triodia* R. Br. (Gramineae) with description of five new species and one variety. *Australian Journal of Botany* 8: 381–394.

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Additions to the lichen flora of Tasmania

G. Kantvilas[1] and A. Vězda[2]

Abstract

Kantvilas, G.[1] & Vězda, A.[2]([1]Tasmanian Herbarium, G.P.O. Box 252C, Hobart, Tasmania, Australia 7001; [2]Botanical Institute, Czechoslovak Academy of Sciences, 602 00 Brno, Tábor 28a, Czechoslovakia) 1992. Additions to the lichen flora of Tasmania. Telopea *4(4): 661–670.* Five new lichens are described. *Arthonia tasmanica* Kantvilas & Vězda, *A. sagenidii* Vězda & Kantvilas and *Arthothelium subspectabile* Vězda & Kantvilas are known only from cool temperate rainforest in Tasmania; *Gyalideopsis graminicola* Vězda & Kantvilas is an endemic Tasmanian alpine lichen and the first record of the genus from Tasmania; *Lecanactis subpremnea* Kantvilas & Vězda is described from the rainforests of Tasmania and Victoria.

1. Arthonia sagenidii *Vězda & Kantvilas*, **sp. nov.**

Mycelium in thallo lichenis (*Sagenidium molle* Stirton) parasitice vel parasymbiotice vigens, haud visibile. Ascocarpia copiosa, minutissima, lentiformia, 0.1–0.15 mm lata, circa 30 µm alta, dispersa vel aggregata, atrofusca. Stratum hypotheciodeum usque ad 10 µm altum, pallide fuscum vel fere incoloratum. Stratum ascigerum circa 25–30 µm altum, plus minusve hyalinum, strato epithecioideo atrofusco, in KOH decolorato. Paraphysoides ramosae anastomosantesque, circa 0.8 µm crassae, apicibus capitatis, nigrofuscis, colore in KOH griseo viridi. Asci clavati, octospori. Ascosporae oblongo-ellipsoideae, incoloratae, 1-septatae, 6–8.5(–9) µm longae, 2–2.2 µm latae.

Type: Australia: Tasmania: Scotts Peak Road, north of Huon River, on thalli of *Sagenidium molle* on dry trunk of *Nothofagus cunninghamii* in rainforest, 560 m, *G. Kantvilas 525/88* p.p., 23 November 1988 (holo HO; iso GZU, herb. Vězda). The type material of *Arthonia sagenidii* has been separated from specimens of *Sagenidium molle* that were distributed as *Lichenes Selecti Exsiccati: 2368.*

Thallus not apparent or absent, mycelium entirely within the thallus of the lichen *Sagenidium molle* as a parasite or parasymbiont. Ascocarps numerous, scattered or crowded, ± roundish and lens-shaped, minute, 0.1–0.15 mm wide, c. 30 µm high, dark brown. Hypothecial layer to 10 µm thick, pale brown to almost colourless. Ascigerous layer, c. 25–30 µm thick, ± hyaline. Epithecioid layer dark brown, fading in KOH. Paraphysoids branched, anastomosing, c. 0.8 µm thick, with capitate, blackish apices, persistently greyish green in KOH. Asci broadly clavate, eight-spored, 20–30 x 8–13 µm. Ascospores colourless, oblong-ellipsoid, consistently 1-septate, 6–8.5(–9) x 2–2.2 µm, the upper cell somewhat larger. Figure 1 (anatomy).

Remarks: *Arthonia sagenidii* is well-characterised by the combination of tiny ascocarps and short, 1–septate ascospores. It occurs exclusively as an apparent parasite or parasymbiont on the thallus of *Sagenidium molle*, a common and widespread lichen in Tasmanian rainforests. The byssoid thallus of *Sagenidium* forms extensive colonies to 60 cm wide in locally dry, sheltered habitats, mostly on the undersides of mature, leaning trees of *Nothofagus cunninghamii*. The new species is very inconspicuous, being visible only as tiny, clustered blackish specks on the surface of the pale greyish *Sagenidium* substrate. It is apparently rare: neither extensive field work nor a search of numerous herbarium specimens of *Sagenidium* revealed more than a

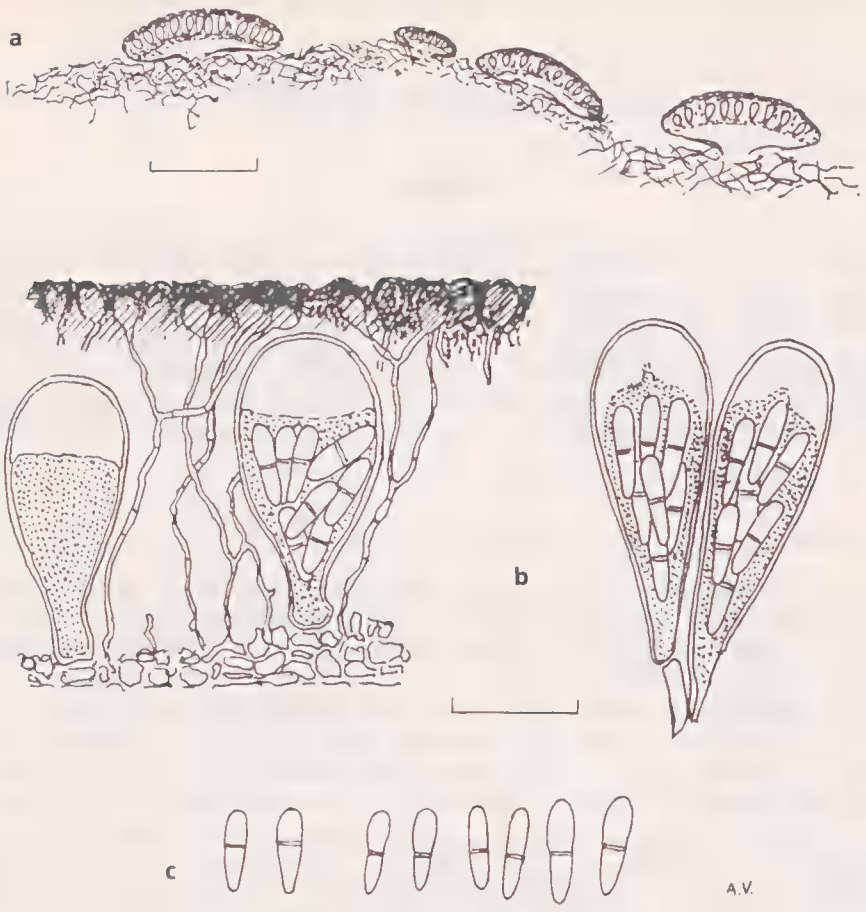

Figure 1. *Arthonia sagenidii*. **a**, Vertical section of four ascocarps (scale = 0.1 mm); **b**, Asci with paraphysoids; **c**, Spores. (scale = 10 µm).

few localities. *Arthonia sagenidii* is frequently associated with *Chaenothecopsis sagenidii*, which shares the same unique habitat and host.

SPECIMENS EXAMINED: AUSTRALIA: TASMANIA: Forest track below Mt Victoria, *G.C. Bratt 73/1225*, 24 November 1973 (HO); Mt Mangana, 420 m, *G.C. Bratt 71/1096*, 7 August 1971 (HO); Hartz Mts National Park, on *Sagenidium molle* on *Nothofagus cunninghamii* in mixed forest, 680 m, *M. Wedin 3006*, 28 January 1990 (HO, UPS); Scotts Peak Road, 2.5 km from Gordon River Road, on *Sagenidium molle* on trunk of *Nothofagus cunninghamii* in rainforest, 550 m, *M. Wedin 3046*, 29 January 1990, (HO, UPS).

2. Arthonia tasmanica *Kantvilas & Vězda*, **sp. nov.**

Thallus crustaceus, epi- et hypophloeodes, tenuissimus, sordide cinereus, laevis vel paulo furfuraceus. Ascocarpia copiosa, rotunda, convexa, atra vel atrofusca, epruinosa, 0.2–0.5 mm lata, 100–130 µm crassa. Stratum hypothecioideum hyalinum

vel pallide fuscum, circa 25–30 µm crassum. Stratum ascigerum hyalinum, usque ad circa 70 µm crassum, strato epithecioideo rufofusco, olivaceo vel immutato in KOH. Paraphysoides sparsae, ramosae anastomosantesque, circa 1 µm crassae. Asci subglobosi, octospori, 40–68 µm longi, 36–56 µm lati. Ascosporae (28–)30–40 x (12–)15–18 µm, ellipsoideae vel parum clavatae, rectae vel interdum curvatae, diu hyalinae, in aetate atrofuscae, leviter constrictae praecipue ad septum medium, persaepe triseptatae, rarissime uni vel quadriseptatae, loculis apicalibus quam centralibus valde minoribus, membranis et septis usque ad 2 µm crassis.

Type: Australia: Tasmania: Little Fisher River, on *Telopea truncata* and *Atherosperma moschatum* in rainforest, 820 m, *G. Kantvilas 708/84C*, 20 October 1984 (holo HO; iso herb. Vězda).

Thallus crustose, epi- and hypophloeodal, dull dingy grey, very thin, smooth to rather scurfy, forming irregular patches mostly less than 3 cm wide, occasionally delimited by a thin black line. Ascocarps numerous, roundish, convex, black to blackish brown, 0.2–0.5 mm wide, 100–130 µm thick, becoming somewhat larger, flatter and irregular in outline with age. Hypothecial layer hyaline to pale brown, c. 25–30 µm thick. Ascigerous layer hyaline, to c. 70 µm thick. Epithecioid layer reddish brown to brown, olivaceous or unchanged in KOH. Paraphysoids sparse, branched and anastomosing, c. 1 µm thick. Asci subglobose, eight-spored, 40–68 x 36–56 µm. Ascospores (28–)30–40 x (12–)15–18 µm, ellipsoid to slightly clavate, straight or occasionally curved, hyaline, becoming grey-brown to dark brown with age, contents mostly greyish and granular, especially in KOH, slightly constricted (mostly across the central septum) almost invariably 3-septate, very rarely 1 or 4 septate with the apical locules markedly smaller than the central ones; walls and septa to 2 µm thick. Figure 2 (anatomy).

Remarks: *Arthonia tasmanica* is an uncommon and easily overlooked species, known from several widely scattered localities in cool temperate rainforest in Tasmania. It occurs on the smooth bark of various phorophytes (as seen in the case of the type collection) in open or semi-shaded conditions such as on young trees in clearings or on canopy twigs. Associated lichens include *Arthothelium ilicinum*, *Catillaria* spp., *Parmelia salcrambidiocarpa*, *Menegazzia weindorferi*, *Sarrameana tasmanica*, *Porina leptaleina*, *Sphaerophorus tener*, *Rinodina dissa* and *Thelotrema lepadinum*.

The new species is characterised by its rather large, three-septate spores. Although most specimens possessed abundant ascocarps, many sections examined revealed only empty asci or asci with very old, collapsed or heavily brown-pigmented spores with thick walls and septa. The KOH+ olivaceous green reaction of the epithecium, a common feature of many taxa of Arthoniaceae, is variable and intermittent in this species and appears to be of only limited taxonomic value. In gross morphology, *Arthonia tasmanica* is rather similar to *Arthothelium ilicinum*, a relatively common species in Tasmanian rainforests with which it frequently co-occurs; *A. ilicinum* has spores of similar overall size but with up to 8 transverse septa and with a significantly enlarged terminal cell.

Specimens examined: Australia: Tasmania: Balts Spur, Tasman Peninsula, on canopy twigs of *Nothofagus cunninghamii* in rainforest, 420 m, *G. Kantvilas 162/83*, July 1983 (HO); Adamsons Falls track, on dead *Anodopetalum biglandulosum* in rainforest, *G. Kantvilas 976/81*, 26 September 1981 (HO); Mt Victoria track, on *Pittosporum bicolor* in rainforest, 950 m, *G. Kantvilas 1190/81*, 8 December 1981 (HO); Weindorfers Forest, on *Nothofagus cunninghamii* in rainforest, 920 m, *G. Kantvilas 614/88*, 6 March 1988 (HO); Anthony Road, on twigs of *Atherosperma moschatum* in rainforest, 580 m, *G. Kantvilas 214/91*, 13 May 1991 (HO); Eastern Arthur Range, c. 1 km south of East Portal, on *Nothofagus cunninghamii* in rainforest, 780 m, *G. Kantvilas 125/91*, 25 March 1991, (HO); Rebecca Road, south of Arthur River, on fallen branch of *Nothofagus cunninghamii*, *J. Glennie 191*, 24 February 1991 (HO).

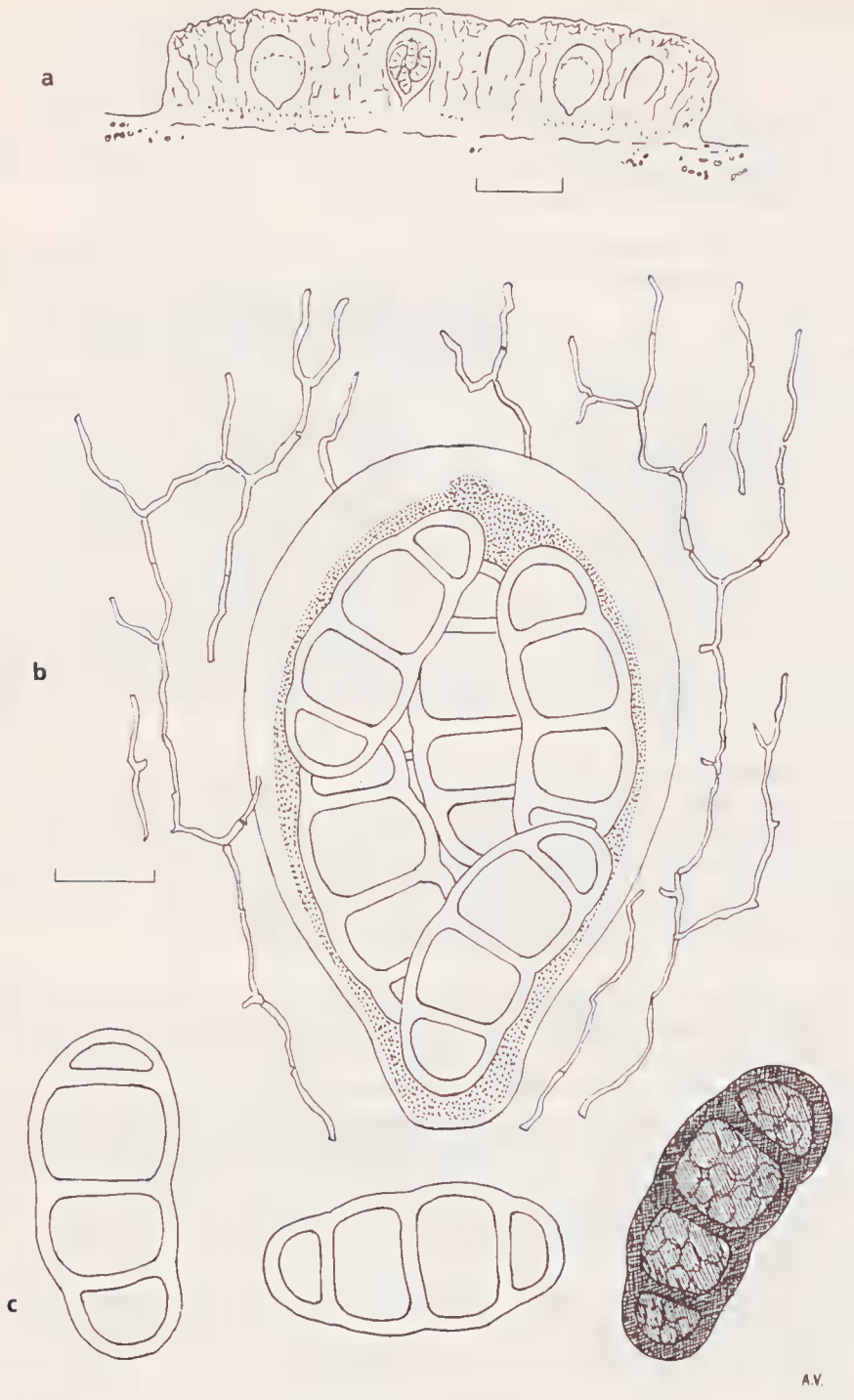

Figure 2. *Arthonia tasmanica*. **a**, Vertical section of ascocarp (scale = 0.1 mm); **b**, Ascus with paraphysoids; **c**, Spores (scale = 10 µm).

3. Arthothelium subspectabile *Vězda & Kantvilas*, **sp. nov.**

Thallus crustaceus, epiphloeodes, pro parte etiam hypophloeodes, cinereo-albidus vel sordide olivaceo-cinereus, laevigatus. Alga ad *Trentepohliam* pertinens. Ascocarpia plus minusve orbicularia, semi-immersa, basin versus constricta, convexa, 0.25–0.4 (–0.6) mm lata, 0.2–0.25 mm alta, nigra, opaca, juniora albopruinosa (pruina grosse granulosa), in aetate nuda. Stratum ascigerum 180–200 µm crassum, incoloratum vel dilute rufofuscum, superne atrofuscum et granulis copiosis inspersum. Paraphysoides ramosae anastomosantesque, circa 1–1.2 µm crassae. Asci subglobosi, 60–70 µm longi, 45–55 µm lati, (2–6–)8-spori. Ascosporae ellipsoideae vel fere ovoideae, muriformes, primum hyalinae, demum atrofuscae, (28–)30–35(–44) µm longae, (14–)15–20 (–24) µm latae.

Type: Australia: Tasmania: 3 km south-east of Mt Agnew, on dry trunk of mature *Nothofagus cunninghamii* in rainforest, 190 m, *G. Kantvilas 135/89*, 6 April 1989 (holo HO; iso herb. Vězda).

Thallus crustose, epiphloeodal and in part hypophloeodal, greyish white to dingy olive-grey, smooth. Photobiont *Trentepohlia*. Ascocarps ± rounded, semi-immersed, constricted at the base, convex, 0.25–0.4(–0.6) mm wide, 0.2–0.25 mm thick, black, opaque, very coarsely granular whitish pruinose when young, soon becoming epruinose. Hypothecial layer poorly developed, ± pale red-brown to colourless. Asciger-ous layer 180–200 µm thick, colourless to pale reddish brown, I+ red, in the upper part dark brown, K+ olive-grey and densely inspersed with numerous ± angular granules; granules mostly to 8 mm wide, dissolving in K. Paraphysoids branched and anastomosing, 1–1.2 µm thick. Asci subglobose, 60–70 µm long, 45–55 µm wide, (2–6–)8-spored. Ascospores ellipsoid to almost ovoid, densely muriform with c. 7–11 transverse and 2–5 longitudinal septa, hyaline at first, becoming dark brown, (28–)30–35 (–44) x (14–)15–20 (–24) µm. Figure 3 (anatomy).

Remarks: *Arthothelium subspectabile* is closely related to the western European species, *A. spectabile* Flotow ex Massal. (see Tehler 1990 for a full description), but differs by its densely granular-white-pruinose young apothecia, by the numerous granules inspersed in the upper part of the hymenium, and by the grey to dark brown mature ascospores. The I+ persistent blue reaction of thalline and subapothecial hyphae, regarded as diagnostic for *A. spectabile* by Coppins & James (1979) was also not observed in the new species. The two species may also differ chemically: Huneck & Follmann (1969) report three unidentified substances in *A. spectabile* but no chemical constituents at all were detected by t.l.c. in the new species.

In Tasmania, there are no species easily confused with *A. subspectabile* which is well-characterised by its relatively small, convex, pruinose apothecia and densely muriform, ± ovate spores. Its micro-habitat (see below) is also not shared by any other known species of *Arthothelium*, although it could well co-occur with several species of the genus *Arthonia*, particularly *A. apteropteridis*.

Arthothelium subspectabile is a rare, easily overlooked species, known from only three localities in cool temperate rainforest in western Tasmania. It occurs on the dry, sheltered and deeply shaded trunks of old mature trees (*Nothofagus cunninghamii* and *Lagarostrobos franklinii*) and grows on rough, fissured bark or on decorticated wood. It is found in the microhabitats typically colonised by the *Lecanactis abietina – Sagenidium molle* community (Kantvilas 1988: 400) and additional lichens with which it can be associated include *Lepraria* spp., *Bactrospora dryina*, *Chaenotheca brunneola* and species of *Chaenothecopsis*.

Specimens examined: Australia: Tasmania: approximately 3 km south of Teepookana, on *Lagarostrobos franklinii* in rainforest, 220 m, *G. Kantvilas 663/90*, 7 November 1990 (HO, herb. Vězda); Badger Creek, c. 2.5 km south of Greystone Bluff, on trunk of mature *Lagarostrobos franklinii* in rainforest, 280 m, *G. Kantvilas 78/89*, 17 February 1989 (HO).

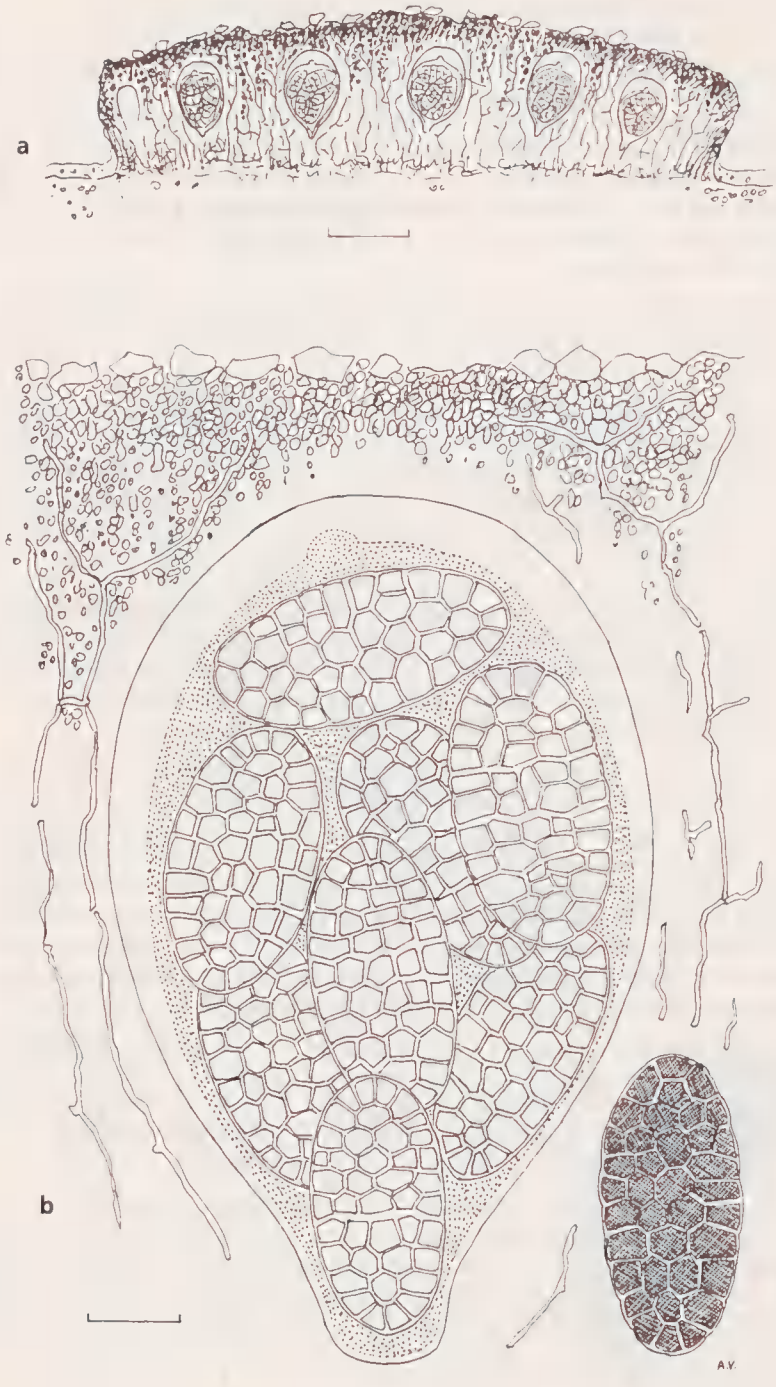

Figure 3. *Arthothelium subspectabile*. **a**, Vertical section of ascocarp (scale = 1 mm). **b**, Ascus with paraphysoids and single, aged, free spore (scale = 10 µm).

4. Gyalideopsis graminicola *Vězda & Kantvilas*, **sp. nov.**

Thallus haud visibilis, in textura foliorum graminis emortui vigens. Algae globosae, virides, insulatim agglomeratae. Hyphophori nulli inventi. Apothecia orbicularia, 0.3–0.5 mm lata, circa 0.1 mm alta, late adnata, basin versus constricta, gyalectoidea, discis concavis vel planis, nigrofuscis, in statu sicco papillis minutissimis nigris munitis, in statu madido fuscis vel rufofuscis subpellucidisque, marginibus persistenter elevatis, integris, nigris, pro parte nitidis. Excipulum 50–60 µm crassum, fuscum vel subhyalinum. Hypothecium circa 40 µm altum, hyalinum. Hymenium (100–)120–150 µm altum, incoloratum. Paraphyses sparsae, anastomosantes, tubulis circa 0.8 µm crassis. Asci clavati, non-amyloidei, octospori. Ascosporae ellipsoideae, hyalinae, 35–50 µm longae, 15–22 µm latae, muriformes, cellulis numerosis, 2–5 µm crassis, mox tamen in cellulas liberas decompositae, conidia singula, bacillaria, 2–2.2 µm longa, 0.5 µm lata producentes.

Type: Australia: Tasmania: northern slopes of Mt Jerusalem, on dead *Poa* tussock in alpine grassland, 1280 m, *G. Kantvilas 114/87*, 8 December 1987 (holo HO; iso herb. Vězda).

Thallus not apparent to absent, growing within the tissue of dead grass leaves. Photobiont green, unicellular, cells subglobose and clustered in colonies. Hyphophores not found. Apothecia circular, 0.3–0.5 mm wide, c. 0.1 mm tall, broadly adnate, constricted at the base, gyalectoid; disc concave to plane, blackish brown, with minute black papillae when dry, brown to reddish brown and subpellucid when moist, especially in younger apothecia; margins persistently raised, entire, black, partly glossy. Excipulum 50–60 µm thick, brown to subhyaline. Hypothecium c. 40 µm thick, hyaline. Hymenium (100–)120–150 µm thick, colourless; paraphyses sparse, anastomosing, 0.8 µm thick; asci clavate, non-amyloid, eight-spored. Ascospores ellipsoid, hyaline, 35–50 x 15–22 µm, strongly muriform with numerous cells to 2–5 µm wide, with age becoming rather greyish-brown and soon disintegrating into free cells, each producing a single bacillar conidium, 2–2.2 x 0.5 µm. Figure 4–5 (anatomy).

Remarks: *Gyalideopsis* is a genus of the Gomphillaceae and currently comprises over 30 species [see James (1975), Galloway (1985) and Vězda & Poelt (1987) for generic characteristics]. The genus is widely distributed and ranges from cool to tropical climates, with an apparent concentration of taxa in tropical America (Kalb & Vězda 1988). Three species are known from subtropical rainforest in Australia, including two corticolous taxa (Vězda & Hafellner 1988) and one as yet undescribed foliicolous species. A further species, also undetermined, is recorded from mosses in New Zealand by Galloway (1985).

The new species is characterised by the absence of a visible thallus, the gyalectoid, plane apothecia and the eight-spored asci with muriform spores. The typically minutely papillose apothecial disc arises from the gradual protrusion of mature asci: the outermost cells of the uppermost spore form a paraplechtenchymatous cortex whilst the remainder of the spore disintegrates into conidia (Figure 5). Such a means of conidial formation from muriform spores is a relatively frequent phenomenon in some foliicolous and corticolous lichens, especially in the families Gomphillaceae and Ectolechiaceae (Santesson 1952: 29).

Gyalideopsis graminicola is a very rare species known only from the type locality, a steep, exposed, badly eroded slope with alpine grassland – heathland mosaic over dolerite, burnt by wildfire approximately 30 years ago. Alpine grassland tends to be an uncommon vegetation formation in Tasmania and usually supports only a depauperate lichen flora of species of *Cladonia* and *Cladia*, and *Lecanora broccha*. The new species was locally common on dead, weather-bleached *Poa* tussocks and mats of dried leaves, and was not associated with any other lichens.

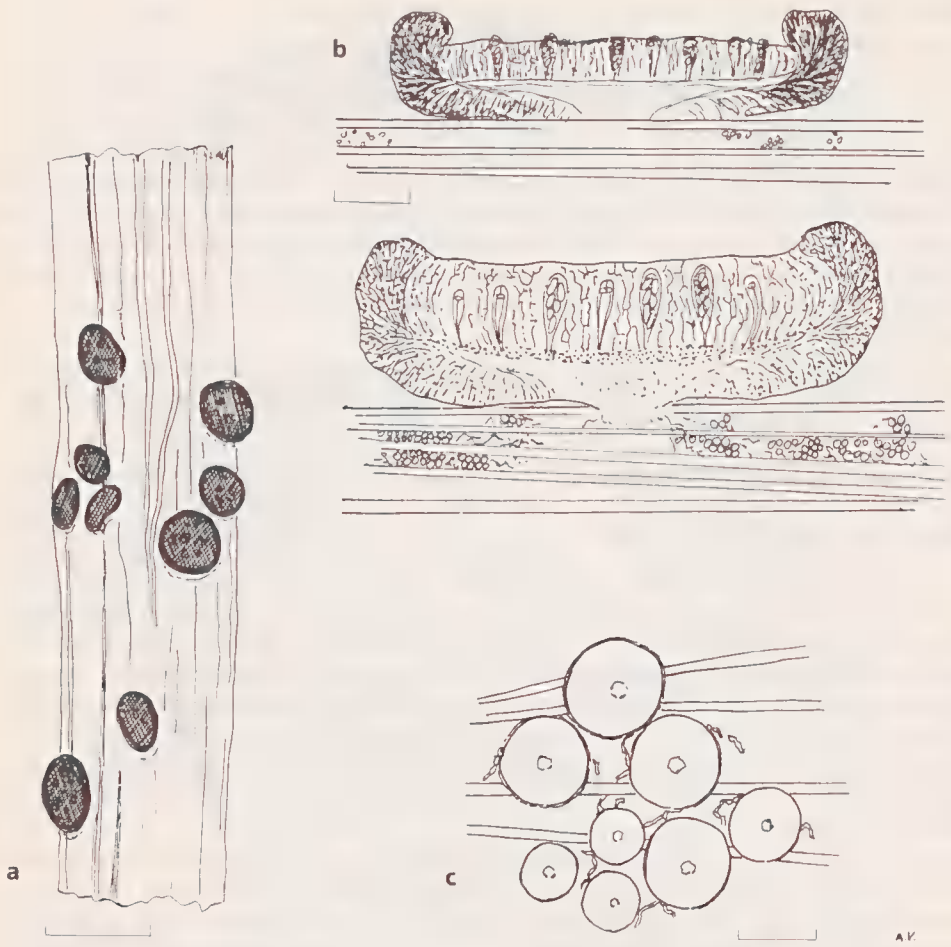

Figure 4. *Gyalideopsis graminicola*. **a**, Habit (scale = 1 mm). **b**, Vertical section of apothecium in dry state (above) and in moist state (below) (scale = 0.1 mm). **c**, Algal cells with mycelial hyphae (scale = 10 µm).

5. Lecanactis subpremnea *Kantvilas & Vězda*, **sp. nov.**

Ex affinitate *Lecanactidis premneae* (Ach.) Arnold a qua differt paraphysibus in apicibus haud nigrofuscis in KOH, sporisque valde majoribus, 30–52 µm longis.

TYPE: AUSTRALIA: TASMANIA: Corinna Road, c. 6 km west of Waratah, on old trunk of *Nothofagus cunninghamii* in rainforest, 600 m, *G. Kantvilas 71/82*, 9 February 1982 (holo HO; iso BM, herb. Vězda, GZU, WELT).

Thallus effuse, rather scurfy, dull olivaceous grey-green, very thin to ± absent. Apothecia black, matt, lecideine, to 1.7 mm diameter; margin prominent, persistent, inrolled and lightly greyish pruinose on the inner edge in very young apothecia; disc concave and ± pruinose only when very young, soon becoming epruinose, plane or

Figure 5 *Gyalideopsis graminicola*. **a**, Ascus with paraphyses; **b**, Old ascus with paraplectenchymatous cortex and decomposed spores, with cells producing conidia; **c**, Spores, LHS producing conidia. (scale = 10 µm).

undulate, sometimes ± excavate when very old. Exciple opaque dark brown to brownish black, slightly paler brown at the inner edges, (80–)85–110 µm thick laterally, K+ olivaceous green, mainly at the edges. Epithecium (6–)10–20 µm thick, dark yellow-brown, colourless to very pale yellow brown in KOH. Hymenium colourless, 90–120 (–130) µm thick. Hypothecium colourless, (60–)80–110 µm thick. Paraphyses numerous, flexuous, 1.2–1.5 µm thick, simple to sparingly branched towards the apices; apices pigmented yellow-brown, colourless in KOH, usually swollen to c. 2.5 µm. Asci narrow cylindrical, non-amyloid, eight-spored, (65–)80–100 x (13–)16–18 µm. Ascospores fusiform, straight or occasionally curved, with rounded apices, (30–)34–52 x 4–7.5 µm, 7–9 (–10) septate, walls to 0.8 µm thick.

Specimens examined: Australia: Tasmania: Near Granville Harbour, on *Atherosperma moschatum* in rainforest, 140 m, *G. Kantvilas s.n.*, 4 March 1982 (HO); Anthony Road, on dry trunk of *Dicksonia antarctica* in rainforest, 450 m, *G. Kantvilas 215/91*, 10 May 1991 (HO, LSU, herb. Vězda). Victoria: Cement Creek, 37° 42' S, 145° 44' E, on *Nothofagus cunninghamii* in rainforest, *G. Kantvilas s.n.*, 6 October 1983 (HO).

REMARKS: *Lecanactis subpremnea* is closely related to the western European species, *L. premnea*, from which it differs chiefly by the pigmentation of the paraphyses (these remain apically black in KOH in *L. premnea*) and the significantly larger spores (17–27 x 4–7 µm in *L. premnea*). The new species is conspicuous but very rare. It is known from cool temperate rainforest in Victoria and western Tasmania where it forms widespreading colonies to c. 20 cm wide on the shaded, dry trunks of mature trees, as well as on the dry fibrous trunks of tree ferns (*Dicksonia antarctica*). *Lecanactis premnea* occupies an analogous niche on old trees in Europe (James et al. 1977).

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References

Coppins, B.J. & James, P.W. (1979) New or interesting British lichens III. *Lichenologist* 11: 27–45.

Galloway, D.J. (1985) *Flora of New Zealand Lichens* (Government Printer: Wellington).

Huneck, S. & Follman, G. (1969) Mitteilungen über Flechteninhaltsstoffe. LXIX. Zur Phytochemie und Chemotaxonomie der Arthoniaceae. *Österr. Bot. Z.* 117: 163–175.

James, P.W. (1975) The genus *Gyalideopsis* Vězda in Britain. *Lichenologist* 7: 155–161.

James, P.W., Hawksworth, D.L. & Rose, F. (1977) Lichen communities in the British Isles: A preliminary conspectus. Pp. 295–413 in M.R.D. Seaward (ed.), *Lichen Ecology* (Academic Press: London, New York, San Francisco).

Kalb, K. & Vězda, A. (1988) Neue oder bemerkenswerte Arten der Flechtenfamilie Gomphillaceae in der Neotropis. *Bibliotheca Lichenologica* 29: 1–80.

Kantvilas, G. (1988) Tasmanian rainforest lichen communities: a preliminary classification. *Phytocoenologia* 16: 391–428.

Santesson, R. (1952) Foliicolous Lichens I. A revision of the taxonomy of the obligately foliicolous, lichenized fungi. *Symb. Bot. Upsal.* 12: 1–590.

Tehler, A. (1990) A new approach to the phylogeny of Euascomycetes with a cladistic outline of Arthoniales focussing on Roccellaceae. *Can. J. Bot.* 68: 2458–2492.

Vězda, A. & Hafellner, J. (1988) Zwei neue *Gyalideopsis* – Arten aus den Regenwäldern Australiens: *G. perlucida* und *G. rogersii* (lichenisierte Ascomycetes, Gomphillaceae). *Preslia* 60: 239–243.

Vězda, A. & Poelt, J. (1987) Flechtensystematische Studien XII. Die Familie Gomphillaceae und ihre Gliederung. *Folia Geobot. Phytotax.* 22: 179–198.

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